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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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W86-00920 -- W86-01319

The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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05 WATER QUALITY MANAGEMENT AND PROTECTION

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Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

ESTIMATED STORE OF SOLUBLE SALTS IN THE LAKE EYRE CATCHMENT IN QUEENSLAND AND THEIR POSSIBLE TRANSPORT IN STREAMFLOW TO THE LAKE,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
R. H. Gunn, and P. M. Fleming.
Australian Journal of Soil Research, Vol. 22, No. 2, p 119-134, 1984. 3 Fig, 6 Tab, 35 Ref.

Descriptors: *Lake Eyre catchment, *Queensland, *Salts, Solute transport, Weathering, Soils, Model studies, Spatial distribution, Rocks, Sodium, Chloride, Nitrates, Ammonium, Bicarbonates, Calcium, Halite, Gypsum, Lakes.

Analytical data from 145 samples of deeply weathered and unweathered rocks and 35 soil samples form the basis for a first approximation estimate of the store of soluble salts in the Lake Eyre catchment covering about 500,000 sq km in Queensland. A simple landscape model is defined to estimate the spatial distribution of the soluble chemical constituents of the various rocks and soils. The estimated quantities of soluble sodium and chloride in the catchment at 14 x 10 to the 9th power and 25 x 10 to the ninth power tons respectively. Some weathered rocks also contain appreciable nitrate and ammonium ions. Available data indicate that bicarbonate, sodium and calcium are the dominant ions in stream flood flows, whereas halite and gypsum are the dominant salts in the lake. Precipitation or reconstitution of degraded clays in the suspended load may account for the absence of carbonates in the lake. It is concluded that the weathered and unweathered Cretaceous sedimentary rocks in the catchment contain large stores of soluble salts, and are the most likely sources of the bulk of the salts in the lake. (Author's abstract)
W86-01031

SIMULATOR FOR WATER RESOURCES IN RURAL BASINS,
Agricultural Research Service, Temple, TX.
J. R. Williams, A. D. Nicks, and J. G. Arnold.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 970-986, June, 1985. 2 Tab, 11 Ref, 1 Append.

Descriptors: *Simulation, *Rural basins, *Hydrologic models, *Computers Water yield, Sediment yield, Weather, Hydrology, Sedimentation, Reservoir storage, Runoff, Flood routing, Model studies, Rural areas, Drainage basins.

A model called SWRRB (Simulator for Water Resources in Rural Basins) was developed for simulating hydrologic and related processes in rural basins. The objective in model development was to predict the effect of management decisions on water and sediment yields with reasonable accuracy for ungaged rural basins throughout the United States. The three major components of SWRRB are weather, hydrology, and sedimentation. Processes considered include surface runoff, percolation, return flow, evapotranspiration, pond and reservoir storage, and sedimentation. The SWRRB model was developed by modifying the CREAMS (Chemicals, Runoff, and Erosion from Agricultural Management Systems) daily rainfall hydrology model for application to large, complex, rural basins. The major changes were: (1) A return flow component was added; (2) the model was expanded to allow simultaneous computations on several sub-basins; (3) a reservoir storage component was added for use in determining the effects of farm ponds and other reservoirs on water and sediment yield; (4) a weather simulation model (precipitation, solar radiation, and temperature) was added to provide for longer-term simulations and more representative weather inputs, both temporally and spatially; (5) a better method was developed for predicting the peak runoff rate; and (6) a simple flood routing component was added. Besides water, SWRRB also simulates sediment yield using the Modified Universal Soil Loss Equation (MUSLE) and a sediment routing model. Tests with data from a 538 sq km basin in Oklahoma and a 17.7 sq km basin in Texas indicate that SWRRB is capable of simulating water and sediment yield realistically. (Author's abstract)
W86-01049

CONTINUOUS CONVOLUTION WITH HYDROLOGIC DATA,
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
T. G. Chapman.
Water Resources Research, Vol. 21, No. 6, p 847-852, June, 1985. 5 Fig, 3 Tab, 7 Ref.

Descriptors: *Hydrologic data, *Convolution equation, Sampling, Algorithms, Mathematical equations, Deconvolution.

The integral form of the convolution equation can be used for hydrologic data sampled at equal time increments of simple functional forms are assumed for the change in the hydrologic variables between sampling points. The forms studied here are a step function, linear segment, and sliding polynomial, and algorithms are presented for convolution of all combinations of these functions. The effect of the different assumptions is demonstrated by a sample data set. These algorithms have three advantages: an appropriate functional form can be selected for the two variables to be convolved, different time increments may be use for the two variables, and the output may be calculated at any point in continuous time, not just at multiples of the sampling increments. The algorithms may also be applied to deconvolution but suffer many of the difficulties of matrix inversion techniques when the data contain errors or are derived from a system which is only approximately linear. (Author's abstract)
W86-01076

STOCHASTIC MODELS APPLIED TO EVALUATING HYDROLOGIC CHANGES,
National Council for Scientific Research, Lusaka (Zambia). Water Resources Research Unit.
T. C. Sharma.
Journal of Hydrology, Vol. 78, No. 1/2, p 61-81, May, 1985. 6 Fig, 6 Ref, 13 Ref.

Descriptors: *Model studies, *Hydrologic models, *Kafue River basin, *Zambia, *Rainfall-runoff relationships, Runoff, Temporal distribution, History, Discharge.

Simple statistical tests for equality of means and variances, and Box-Jenkins univariate and input-output models were applied to the Kafue River Basin, Zambia, to detect hydrologic changes. The structural deconposition of monthly runoff series into periodic and stochastic components, and the step response function of monthly runoff processes in relation to monthly rainfall processes provide parameters that form a basis for evaluating the changes in the hydrologic environments. The hydrologic changes were found to be reflecting changes of the model parameters in the following manner: (1) The steady-state or the equilibrium value for the rainfall-runoff step response function rose after the mid-1930's, suggesting that the potential of the basin increased for generating the runoff water. (2) The time constant (months) for the monthly rainfall-runoff system increased after the mid-1930's, suggesting that the transmission capability of the system for transporting the generated runoff tended to slow down during the same period. (3) The role of the stochastic component in influencing the monthly runoff process grew after the mid-1930's. The stochastic component behaved as a Markov or AR(1) process before the mid 1930's, while the behavior of the stochastic component resembled an ARMA(1,1) process after that. (4) The levels of yearly and monthly runoff depths (discharges), yearly maximum daily discharges and yearly minimum daily discharges underwent a general rise after the mid-1930's. (Author's abstract)
W86-01293

2B. Precipitation

STATISTICAL-METEOROLOGICAL EVALUATION OF TWO OPERATIONAL SEEDING PROJECTS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 3B.
W86-01136

HIGHEST OBSERVED 1 TO 10-DAY POINT AND AREAL RAINFALL OVER KERALA STATE,
Indian Inst. of Tropical Meteorology, Poona.
S. A. Saseendran, P. R. Rakhecha, and O. N. Dhar.
Indian Journal of Power and River Valley Development, Vol. 33, No. 12, p 438-443, December, 1983. 10 Fig, 4 Tab, 5 Ref.

Descriptors: *Rainfall, *Kerala, *India, Rainfall area, Rainfall distribution, Altitude.

Daily rainfall data of about 100 stations in and around Kerala State (India) for a period of 70 years from 1901-1970 have been analyzed to determine the the highest rainfall amounts for 1 to 10-day durations. Using the highest rainfall data at each of 100 stations a family of generalized highest rainfall charts of 1 to 10-day durations were prepared. The highest 1-day rainfall values range from 21 to 53 cm. Heavy falls of rain of 40 cm or more in one day are confined to areas close to the Western Ghats on their windward sides. The 2-day highest rainfall varies from 31-85 cm. The highest point rainfall values for 10-day rainfall ranged from 62-243 cm. A common feature revealed by all the maps is that high rainfall values occur over and near the Western Ghats and isolines of rainfall almost run parallel to the contour lines. Vayittiri station recorded the highest rainfall amounts for all 10 durations. At the rainiest stations about 30% of the maximum rainfall in a 10-day duration is recorded in one day and about 40-50% in 2 day duration. (Moore-IVI)
W86-01223

RECENT CHANGES IN SUMMER RAINFALL VALUES MEASURED AT LONG ASHTON,
Bristol Weather Center (England).
M. R. Woodley.
Weather, Vol. 40, No. 6, p 180-183, June, 1985. 5 Fig, 1 Tab.

Descriptors: *Seasonal variation, *Rainfall, *England, *Long Ashton, Drought, Water supply.

Changes in summer rainfall amounts in one part of the south-west of England are documented. Differences between the 1984 dry spell and the one in 1975-76 are also noted. Analysis of annual rainfall totals considered as a 25 year running mean shows an irregular decline from 1944 until 1979, after which all but one of the following years had above average rainfall. Even so, over the period as a whole, this represents a decline of about 52 mm in average annual values, using linear regression. For the period 1972-78 when the rate of change was at its greatest, the decrease was significant at the one percent level. A decrease in rainfall is noted in the mid-1970s, with its nadir in August 1976, and another very low point in November 1978. Thereafter, monthly rainfall amounts were frequently above average so that the cumulative difference from the 30-year average had returned to near zero by January 1983. Seasonal rainfall for the summer months shows an altogether different pattern. During 1971-84 there were four very dry summers and only one very wet summer. In the 13 year period from 1979-84 there were only three summers with above average rainfall. Put against the changes in annual rainfall values it becomes clear that the present dry spells are set against above-average rainfall in the preceding four or five years, whereas the drought of the mid-1970s was part of a continuing decline in annual rainfall. (Baker-IVI)
W86-01303

2C. Snow, Ice, and Frost

MACHINE CLASSIFICATION OF FRESHWATER ICE TYPES FROM LANDSAT-1 DIGITAL DATA USING ICE ALBEDOS AS TRAINING SETS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
G. A. Leshkevich.
Remote Sensing of Environment, Vol. 17, No. 3, p 251-263, June, 1985. 5 Fig, 1 Tab, 38 Ref.

Descriptors: *Ice, *Albedo, *Landsat-1, *Remote sensing, *Green Bay, *Great Lakes, *Lake Michigan, Satellite technology, Reflectance, Lake ice.

A method has been used to convert ground-measured freshwater ice albedos to Landsat-1 digital numbers indirectly corrected for atmospheric attenuation and path radiance. The method has been tested by using the digital numbers as training sets to machine classify Landsat-1 digital ice cover data from a portion of northern Green Bay (Lake Michigan) imaged on 13 February 1975. The conversion algorithm produced digital numbers that, when used as training sets, classified approximately 50% of the test area. Differences between the classified test area and a previous machine classification of the scene, as well as the percentage of unclassified area caused by lack of data for some surface types, points to the need for a more comprehensive, well-documented library of signatures representing Great Lakes ice types. (Author's abstract)
W86-01288

2D. Evaporation and Transpiration

EVAPOTRANSPIRATION DERIVED FROM SATELLITE OBSERVED SURFACE TEMPERATURES,
Utrecht Rijksuniversiteit (Netherlands). Inst. voor Meteorologie en Oceanografie.
W. Klaassen, and W. van Den Berg.
Journal of Climate and Applied Meteorology, Vol. 24, No. 5, p 412-424, May, 1985. 17 Fig, 1 Tab, 38 Ref.

Descriptors: *Evapotranspiration, *Satellite technology, *Remote sensing, *Soil temperature, *Surface temperatures, Energy balance method, Wind velocity, Air temperature, Model studies.

Evapotranspiration was calculated from surface temperatures using an energy balance method. This method is sensitive to the temperature difference between the surface and the air above, and somewhat to the windspeed. The influence of the spatial variability of air temperature on the interpretation of surface temperatures was considered. Small-scale atmospheric variations can be corrected by using temperature and wind data at a height of 50 m. Three models have been used to calculate these 50 m data from standard weather observations. The first model uses a very simple concept of constant temperature and wind over the test area (zero-dimensional). In the second model windspeed is also taken constant, but air temperature is evaluated from the initial vertical temperature in the atmosphere with a one-dimensional slab layer model. The third model is a two-dimensional primitive equations model in which wind velocity is calculated from the geostrophic wind and air temperature similar to model 2. A homogeneous grassland area was selected in the north of the Netherlands close to the sea. Several days in the summer of 1983 with clear skies and winds from the sea were selected. Surface temperatures were derived from the NOAA-7 satellite overpass in the early afternoon using the split-window technique. On most days an almost linear increase of both surface and air temperature is found with increasing distance to the sea. This study reveals that 1 results in an unrealistic decrease of the calculated evapotranspiration with increasing distance to the coast. Furthermore evapotranspiration is underestimated. The evapotranspiration as calculated with models 2 and 3 is almost constant in the test area and agrees well with measurement. Model 3 gave more scatter, probably due to the fact that uncalibrated wind velocities were used. For practical calculation of evapotranspiration the Priestley-Taylor parameter 'alpha' is often used. This study shows how this parameter can be derived from satellite observations of surface temperature. (Author's abstract)
W86-01135

STOMATAL RESPONSES AND WATER RELATIONS OF EUCALYPTUS PAUCIFLORA IN SUMMER ALONG AN ELEVATIONAL GRADIENT,
Innsbruck Univ. (Austria). Botanisches Inst.
C. Korner, and P. M. Cochrane.
Oecologia, Vol. 66, No. 3, p 443-455, June, 1985. 12 Fig, 8 Tab, 68 Ref.

Descriptors: *Plant physiology, *Stomata, *Eucalyptus, *Australia, *Snowy Mountains, *Leaves, *Leaf conductance, *Trees, Plant water potential, Water potentials, Altitude, Elevation, Preciptation, Evaporation, Humidity, Soil water, Water balance.

The spatial and temporal variation of leaf conductance (g) in Eucalyptus pauciflora was analyzed with respect to photon flux area density (I), temperature (T), water vapor concentration deficit (Delta w), and leaf water potential (Psi) at four different sites between 940 m and 2,040 m altitude in the Snowy Mountains of south-eastern Australia. Along this altitudinal gradient the precipitation/evaporation ratio increases from 1 to 4. The results show that gas diffusion in this tree species is primarily controlled by I and Delta w at all sites, independently of the specific soil moisture regimen. Even under dry midsummer conditions with predawn leaf water potentials of - 1 MPa at the lowest altitude, Psi had no striking effect on g. The humidity threshold for the onset of stomatal closure does not vary greatly between the study sites (12.2 + or - 1.3 Pa/kPa). The highest and lowest values observed for Psi, the osmotic potential at water saturation (from pressure/volume curves), the mean and maximum g and stomatal density, all increase with elevation. The highest (least negative) osmotic potentials were obtained at all sites in midsummer. It therefore appears that there is no osmotic adjustment to drought in the seasonal course. The maximum difference between osmotic potentials obtained at the lowest and highest sites is 0.46 MPa. In general osmotic potential varies less than has been reported for other plant species exposed to varying water regimens. This may be the consequence of the pronounced feed-forward response of the stomata to evaporative demand, which led to only moderate tissue desiccation, never exceeding the turgor loss point. E. pauciflora is a tree species with a very conservative utilization of soil water, which adjusts to drought via stomatal control of water loss, rather than via osmotic properties. These results explain previous reports of the comparatively high susceptibility of E. pauciflora to severe drought and its positive influence on the hydrological balance of mountain ecosystems in the Australian Alps. (Author's abstract)
W86-01163

2E. Streamflow and Runoff

NEGATIVE OUTFLOWS FROM MUSKINGUM FLOOD ROUTING,
Agricultural Research Service, Columbia, MO. North Central Watershed Research Unit.
A. T. Hjelmfelt, Jr.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 1010-1014, June, 1985. 15 Ref.

Descriptors: *Muskingum Flood Routing, *Flood routing, *Flood control, Floods, Mathematical equations.

The Muskingum flood routing equation was treated as a difference form of a discrete linear response function. The response function, which represents the routine of a unit impulse through the system, was investigated to determine the criterion for ensuring only positive ordinantes. Realistic inflow sequences may be routed with less severe restrictions and still have only positive outflows, but the criterion will depend upon the inflow sequence. Practical application of the Muskingum method will seldom yield negative ordinates. (Baker-IVI)
W86-01052

RELATIVE ACCURACY OF LOG PEARSON III PROCEDURES,
Institute of Hydrology, Wallingford (England).
J. R. Wallis, and E. F. Wood.
Journal of Hydraulic Engineering, Vol. III, No. 7, p 1043-1056, July, 1985. 5 Fig, 4 Tab, 16 Ref.

Descriptors: *Flood frequency, *Probability distribution, *Pearson III, Algorithms, Computers, Statistical methods.

The performance of the U.S. Water Resources Council (WRC) flood frequency procedures, and computer algorithm was tested and compared to alternative flood frequency procedures under the assumption that flood frequency follows a log-Pearson III probability distribution, Among the WRC procedures, the one that performed best used a weighted log-skew coefficient based upon the average regional log-skew and the at-site log-skew. Using only the average regional log-skew was essentially as good. The alternative regional procedures GEV/PWM (generalized extreme value/probability weighted moments) and the WAK/PWM (Wakeby/probability weighted moments) performed significantly better. The WRC procedures provided especially poor estimates for basins with negative skews in the log transformed data. Since a significant portion of flood data exhibit negative skews in log-space, the use of the WRC procedures on such data is an additional cause of concern. The WRC flood frequency procedures should not be used as a basis for engineering design because significantly more accurate estimates can be obtained by other currently available statistical procedures. (Moore-IVI)
W86-01091

SIMILARITY SOLUTION OF OVERLAND FLOW ON PERVIOUS SURFACE,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
A. O. Akan.
Journal of Hydraulic Engineering, Vol. III, No. 7, p 1057-1067, July, 1985. 5 Fig, 3 Tab, 16 Ref.

Descriptors: *Overland flow, *Infiltration, *Similarity solution, Mathematical models, Pervious soils, Flood peak.

Similarity solutions for the overland flow-infiltration problem are obtained by use of a physically-based mathematical model. The mathematical model is founded on the kinematic equations of overland flow and the Green-Ampt formulation of the infiltration process. The governing equations of surface flow and infiltration are coupled and rewritten in terms of four physically-based nondimensional parameters. Constant values of these parameters imply hydraulic similarity of an infinite number of different overland flow-infiltration situations. An implicit finite difference technique is employed to solve the governing equations. The similarity approach is verified by comparisons of similarity solutions with the results of a theoretically sophisticated mathematical model for the cases of Columbia sandy loam, Yolo light clay, and Guelph loam. Also, a group of peak discharge prediction charts are developed based on the similar solutions of the overland flow-infiltration problem and presented to emphasize the feasibility of the similarity approach. The use of these charts is illustrated by a practical application section included in the paper. (Author's abstract)
W86-01092

SUBDIVISION FROUDE NUMBER,
Geological Survey, NSTL Station, MS. Gulf Coast Hydroscience Center.
D. H. Schoelhamer, J. C. Peters, and B. E. Larock.
Journal of Hydraulic Engineering, Vol. 111, No. 7, p 1099-1104, July, 1985. 1 Fig, 2 Tab, 7 Ref.

Descriptors: *Flow, *Froude number, Floods, Flood control, Mathematical equations, Water surface.

The standard step method calculates one-dimensional steady state water surface profiles by iterating upon the equations for energy conservation and head loss between adjacent cross sections. The development and testing of a subdivision Froude number with which the flow regime in each of the three major cross-sectional subdivisions can be identified is described. A knowledge of the magnitude of the subdivision Froude numbers improves the engineer's ability to identify mixed flow regimes and shallow floodplain flow, both of which invalidate the assumptions of the standard step method. A two-dimensional analysis is probably more appropriate in these circumstances. (Baker-IVI)
W86-01094

UNIFORM TECHNIQUE FOR FLOOD FREQUENCY ANALYSIS,
Geological Survey, Reston, VA.
W. O. Thomas, Jr.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 321-337, July, 1985. 3 Fig, 36 Ref, 1 Append.

Descriptors: *Flood frequency, Estimation, Frequency distribution, Frequency analysis, Flood peak, Pearson III distribution.

In 1967 the U.S. Water Resources Council (WRC) published Bulletin 15 recommending that a uniform technique be used by all Federal agencies in estimating floodflow frequencies for gaged watersheds. This uniform technique consisted of fitting the logarithms of annual peak discharges to a Pearson Type III distribution using the method of moments. The objective was to adopt a consistent approach for the estimation of floodflow frequencies that could be used in computing average annual flood losses for project evaluation. In addition, a consistent approach was needed for defining equitable flood-hazard zones as part of the National Flood Insurance Program. In 1976 WRC published Bulletin 17 which extended and updated Bulletin 15 but still recommended the use of the 'log-Pearson Type III' method. Since 1976, two updates of Bulletin 17 (17A and 17B) have been published which clarify or improve on this base method, or do both. This paper gives a brief historical review of the development of these bulletins and the motivation and justification for the adoption of this uniform technique. Special emphasis is given to Bulletin 17B, the current guidelines used by Federal agencies. Specific techniques examined are the development fo regional skew, weighting of regional and station skew, the basis for the low- and high-outlier tests, and the basis for the adjustment of frequency curves using historical information. (Author's abstract)
W86-01106

STREAMFLOW VARIABILITY IN THE UNITED STATES: 1931-78,
Geological Survey, Reston, VA.
H. F. Lins.
Journal of Climate and Applied Meteorology, Vol. 24, No. 5, p 463-471, May, 1985. 5 Fig, 3 Tab, 24 Ref.

Descriptors: *Streamflow, *Temporal distribution, *Trends, Statistical analysis, Flow, Surface flow, Surface water records.

Systematic modes of spatial and temporal variation in a 48-year record of streamflow were defined using principal components. The components were calculated from a matrix of annual streamflow departures for 106 grid cells covering the United States in the years 1931-78. Five statistically significant components account for more than 56% of total variance. A varimax orthogonal rotation of the original components describes regional anomaly cores located in the middle Mississippi Valley, Pacific Northwest, Far West, Northeast, and northern Great Plains. Each of these patterns is an enhancement of a less well defined spatial form apparent in the unrotated solution. Temporal variations in the scores of all five components closely agree with contemporaneous national and regional departure patterns in several climatic variables. (Author's abstract)
W86-01137

ESTIMATION OF DISCHARGE AND LOADS FROM THE RIVERS FLOWING INTO LITTORAL SEAS OF CHINA (IN CHINESE),
Academia Sinica, Beijing (China). Inst. of Geography.
For primary bibliographic entry see Field 2J.
W86-01167

RECOVERY OF A STREAM INVERTEBRATE COMMUNITY FROM A FLASH FLOOD IN TESUQUE CREEK, NEW MEXICO,
New Mexico Univ., Albuquerque. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W86-01170

DIRECT MEASUREMENTS OF SECONDARY CURRENTS IN A MEANDERING SAND-BED RIVER,
Queen Mary Coll., London (England). Dept. of Geography and Earth Science.
C. R. Thorne, L. W. Zevenbergen, J. C. Pitlick, S. Rais, and J. B. Bradley.
Nature, Vol. 315, No. 6022, p 746-747, June, 1985. 2 Fig, 13 Ref.

Descriptors: *Meandering streams, *Unstable channels, *River beds, *Secondary currents, Water currents, Stream beds, Channel erosion, Channeling, Hydraulics.

Natural channels often adopt a meandering course. Water flow in meander bends is three-dimensional, consisting of primary velocities which are tangential to the bend, and secondary velocities, which are in the radial plane. The pattern of secondary flow strongly affects the distribution of primary velocities. This in turn affects the distribution of erosion and deposition in the bend and the way in which the channel shifts and changes shape. Measurements of primary and secondary flows in a meandering gravel-bed river show that, in addition to the widely recognized main secondary circulation driving surface water outwards and bed water inwards, there can be a small cell of reverse rotation at the outer bank. Further data have been collected in a sand-bedded river at low, intermediate and high discharges. The results confirm the existence of the main and outer bank cells but also indicate that in some bends the main cell does not extend to the inner bank. In fact, secondary flow at the inner bank of wide, shallow bends is directed radially outwards over the whole flow depth at all in-channel flows. This indicates that some models of bend flow and channel development may be significantly in error. (Author's abstract)
W86-01171

COLLECTION AND ANALYSIS OF URBAN RUNOFF DATA IN FINLAND,
National Board of Waters, Helsinki (Finland). Technical Research Office.
For primary bibliographic entry see Field 5D.
W86-01251

COVARIANCE BETWEEN SUBSAMPLE MEAN AND VARIANCE AS RELATED TO STORAGE VARIABLES,
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
M. Bayazit, J. T. B. Obeysekera, and V. Yevjevich.
Journal of Hydrology, Vol. 78, No. 1/2, p 137-150, May, 1985. 9 Fig, 8 Ref.

Descriptors: *Covariance, *Hydrologic modeling, *Flow, *Statistical analysis, *Storage, Model studies, Data interpretation, Seasonal variation, Flow regulation.

The covariance between mean and variance of subsamples was conceived as a single parameter which integrates the effects of asymmetrical extremes and dependence structure on storage capacity required for seasonal flow regulation. An exact expression for this covariance for the first-order autoregressive processes was derived. The use of covariance for estimation of skewness was investigated by simulation for both independent and dependent stationary processes. This approach results in a lesser bias in estimated skewness than the moment estimator. The relationship between covariance and the storage related variables, such as range and deficit, was studied by simulation. Covariance was positively correlated with mean range and deficit for skewness smaller than 3, and negatively correlated with adjusted range. These storage related variables are influenced in different ways by the sampling fluctuations in the coefficients of skewness and serial correlation. (Author's abstract)
W86-01297

2F. Groundwater

CONTRIBUTION TO THE ANALYTICAL DESCRIPTION OF TRANSPORT PROCESSES IN THE AQUIFER AT A DIFFUSE SUBSTANCE INPUT (BEITRAG ZUR ANALYTISCHEN BESCHREIBUNG VON TRANSPORTPROZESSEN IM GRUNDWASSERLEITER BEI DIFFUSEM STOFFEINTRAG),
Institut fuer Wasserwirtschaft, Berlin (German D.R.).
For primary bibliographic entry see Field 5B.
W86-01012

RADIOCARBON DATING OF GROUNDWATER IN TERTIARY SEDIMENTS OF THE EASTERN MURRAY BASIN,
Water Resources Commission of New South Wales, Sydney (Australia).
L. W. Drury, G. E. Calf, and J. K. Dharmasiri.
Australian Journal of Soil Research, Vol. 22, No. 4, p 379-387, 1984. 4 Fig, 3 Tab, 10 Ref.

Descriptors: *Carbon radioisotopes, *Groundwater, *Murray Basin, *New South Wales, Geohydrology, Groundwater recharge, Groundwater movement, Radioactive dating.

The Tertiary sediments located in the eastern part of the Murray Basin contain one of the most important low salinity groundwater resources in New South Wales. This has been especially apparent during recent years as increasing demands on the resource are being made by irrigators and municipal water suppliers. It is therefore imperative that the hydrogeological environment in which the groundwater occurs by thoroughly understood to allow adequate management of the resource. As part of a systematic exploration of the Tertiary aquifer systems, the Australian Atomic Energy Commission, in association with the Water Resources Commission of New South Wales, carried out a radiocarbon dating project on 37 groundwater samples from bores screened in these unconsolidated sediments. The results indicate water ages in the ranges 'modern' to 15,800 years. Groundwater recharge areas are indicated and rates of groundwater recharge and movement determined. The latter shows close correlation with velocity values quantitatively determined by Darcy's law. (Author's abstract)
W86-01036

UNSATURATED AND SATURATED FLOW THROUGH A THIN POROUS LAYER ON A HILLSLOPE,
Western Australia Univ., Nedlands. Dept. of Mathematics.
D. G. Hurley, and G. Pantelis.
Water Resources Research, Vol. 21, No. 6, p 821-824, June, 1985. 3 Fig, 10 Ref.

Descriptors: *Unsaturated flow, *Saturated flow, *Storm seepage, *Slopes, Porous media, Infiltration, Kinematic wave theory, Water table, Mathematical equations, Hills.

The subsurface stormflow in a layer of porous earth overlying an impervious hill is investigated in

the case when the thickness of the layer is small compared to a typical hill dimension. If the infiltration rate at the surface is low and varies slowly with time, the head is approximately constant along normals to the hillslope, and the flow in both the saturated and unsaturated regions is described by a simple kinematic wave equation. Solutions of this equation describe the spatial and temporal development of the water table as well as the flow in the saturated and unsaturated regions. A numerical example is given. (Author's abstract)
W86-01073

COMPARISON OF GAUSSIAN CONDITIONAL MEAN AND KRIGING ESTIMATION IN THE GEOSTATISTICAL SOLUTION OF THE INVERSE PROBLEM,
Calvin Coll., Grand MI. Dept. of Engineering.
R. J. Hoeksema, and P. K. Kitanidis.
Water Resources Research, Vol. 21, No. 6, p 825-836, June, 1985. 19 Fig, 1 Tab, 11 Ref, 1 Append.

Descriptors: *Geohydrology, *Geostatistical methods, *Mathematical models, *Kriging, *Inverse problem, Transmissivity, Hydraulic head, Aquifers, Pumping, Groundwater.

Two separate applications of the geostatistical solution to the inverse problem in groundwater modeling are presented. Both applications estimate the transmissivity field for a two-dimensional model of a confined aquifer under steady flow conditions. The estimates are based on point observations of transmissivity and hydraulic head and also on a model of the aquifer which includes prescribed head boundaries, leakage, and steady state pumping. The model used to describe the spatial variability of the log-transmissivity describes large-scale fluctuations through a linear mean or drift intermediate and small-scale fluctuations through a two-parameter covariance function. The first application presented estimates the log-transmissivities using Gaussian conditonal mean estimation. The second application uses extended form of cokriging. The two methods are compared and their relative merits discussed. The extended cokriging application is applied to the Jordan Aquifer of Iowa. A comparison is also made between the conditional mean application and an analytical approach. (Author's abstract)
W86-01074

VARIANCE REDUCTION ANALYSIS,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
S. Rouhani.
Water Resources Research, Vol. 21, No. 6, p 837-846, June, 1985. 4 Fig, 2 Tab, 37 Ref.

Descriptors: *Variance reduction analysis, *Sampling, *Algorithms, Groundwater, Costs, Planning, Network design.

An attempt is made to develop a data collection algorithm, known as the variance reduction analysis. The proposed method is based on an information response function (i.e., the amount of information gain at an arbitrary point due to a measurement at another site. This method was later applied to groundwater data management problems. Total variance reduction (a measure for the information gain) which is independent of measured values was used as a tool for the design and planning of such data collection schemes. By utilizing a loss function, planners can estimate monetary values of the added data. By assuming that measurement fluctuations are normally distributed, a two-piece linear loss function yielded an expected loss that was directly proportional to the square root of the kriging variance. The two indicators of information and economic gains led to an optimal sampling scheme. Based on the information gain function, selected points were ranked as prospective new sampling sites. Using the economic gain function, the optimal number of added points was calculated as a function of cost-loss ratio. The selected sequence of sites for further sampling shows a high degree of stability with respect to noisy inputs. The variance reduction analysis is an effective algorithm for the planning and design of data collection schemes in random fields. (Moore-IVI)
W86-01075

QUANTITATIVE ANALYSIS OF THE LASSEN HYDROTHERMAL SYSTEM, NORTH CENTRAL CALIFORNIA,
Geological Survey, Menlo Park, CA.
S. E. Ingebritsen, and M. L. Sorey.
Water Resources Research, Vol. 21, No. 6, p 853-868, June, 1985. 14 Fig, 2 Tab, 26 Ref.

Descriptors: *Lassen Volcanic National Park, *California, *Geothermal resources, Hydrothermal studies, Chlorides, Steam, Mathematical models, Simulation, Groundwater movement.

This conceptual model of the Lassen system is termed a liquid-dominated hydrothermal system with a parasitic vapor-dominated zone. The essential feature of this model is that steam and steam-heated discharge at relatively high altitudes in Lassen Volcanic National Park (LVNP) and liquid discharge with chloride concentrations at relatively low altitudes outside LVNP are both fed by an upflow of high-enthalpy two-phase fluid within the Park. Liquid flows laterally away from the upflow area toward the areas of high-chloride discharge, and steam rises through a vapor-dominated zone to feed the steam and steam-heated features. Numerical simulations show that several conditions are necessary for the development of this type of system, including (1) large-scale topographic relief; (2) an initial period of convective heating within an upflow zone followed by (3) a change in hydrologic or geologic conditions that initiates drainage of liquid from portions of the upflow zone; and (4) low-permeability barriers that inhibit the movement of cold water into the vapor zone. Simulations of thermal fluid withdrawal south of LVNP, carried out in order to determine the effects of such withdrawal on portions of the hydrothermal system within the Park, generally showed decreases in pressure and liquid saturation beneath the vapor zone which resulted in temporary increases and subsequent decreases in the rate of upflow of steam. A generalized production-injection scenario that could mitigate the effects of development on both the high-chloride and steam-fed features was identified. (Author's abstract)
W86-01077

IDENTIFICATION OF PARAMETER STRUCTURE IN GROUNDWATER INVERSE PROBLEM,
Shandong Univ., Jinan (China). Dept. of Mathematics.
N.-Z. Sun, and W. W.-G. Yeh.
Water Resources Research, Vol. 21, No. 6, p 869-883, June, 1985. 11 Fig, 5 Tab, 27 Ref. MAF grants CEE 81-13500 and CEE 83-01230.

Descriptors: *Groundwater, *Inverse problem, *Parameter structure, *Model studies, Optimization, Mathematical studies.

This paper develops an optimization method that can be used to identify parameter structure as well as its values in connection with the inverse problem in groundwater modeling. The complexity of the parameter structure is determined by the quantity and quality of observation data. Output least square error is used as the criterion of identification. Sensitivity coefficients at finite element nodes are evaluated by the variational method. The problem of identifying the parameter structure is formulated as a problem of combinatorial optimization. A new parameterization technique is presented for describing the parameter structure. It can represent various distributions of parameters from piecewise constant to continuous variability. Based on this representation, the combinatorial optimization problem for determining the parameter structure is then solved by a simple one-at-a-time searching procedure. Numerical experimentations are used to demonstrate the efficiency and practicality of the proposed method. (Author's abstract)
W86-01078

NUMERICAL DETERMINATION OF AQUIFER CONSTANTS,
National Univ. of Singapore. Dept. of Civil Engineering.
S. P. Rai.
Journal of Hydraulic Engineering, Vol. 111, No. 7, p 1110-1114, July, 1985. 2 Tab, 5 Ref.

Descriptors: *Aquifer properties, *Mathematical equations, Water storage, Transmissibility, Permeability, Pumping tests.

A simple method is presented by which the aquifer constants of confined infinite aquifer can be calculated numerically without the necessity of a curve fitting to calculate the values of the storage coefficient assumed constant for homogeneous isotropic aquifer or the transmissibility of the aquifer of constant thicknesss and uniform permeability. The method can be used if only a few sets of pumping test data are available. The accuracy of the method is of the same order as of the other graphical methods. (Baker-IVI)
W86-01096

INVENTORYING GROUND WATER IN CRYSTALLINE ROCKS OF PIEDMONT REGION,
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
C. W. Welby.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 293-302, July, 1985. 4 Fig, 1 Tab, 16 Ref.

Descriptors: *Groundwater budget, *Piedmont Region, Geology, Pumping tests, Groundwater potential, Base flow, Groundwater movement.

A methodology is described for estimating a 'Ground Water Working Inventory' for areas of the eastern Piedmont Province drawing ground water from crystalline rocks. The approach can improve efficiency in water resource and land-use planning and use of surface and ground water resources. Calculation of the 7-day, 10-year and 7-day, 1 year flows from stream gage data together with application of geologic data and information calculated from 24-hr pumping tests allow the outlining of areas more favorable and less favorable for ground water development. The Ground Water Working Inventory based on the 7-day low-flow calculations allows estimates of available water to be made and permits land-use planners to make rational decisions about residential densities and other water-related issues. Political bodies and planners can use the methodology to guide development according to how large a role ground water is to play in local water supply planning and management. High density development can be discouraged in those areas where ground water is limited and encouraged where commitments for surface water supplies have been made. Additionally, the inventory provides information which strengthens planning for use of ground water as a supplement to surface water supplies. (Author's abstract)
W86-01104

PRACTICAL METHOD FOR MODELING FLUID AND HEAT FLOW IN FRACTURED POROUS MEDIA,
California Univ., Berkeley. Lawrence Berkeley Lab.
K. Pruess, and T. N. Natasimhan.
Society of Petroleum Engineers Journal, Vol. 25, No. 1, p 14-26, February, 1985. 8 Fig, 2 Tab, 27 Ref. DOE contract W-7405-ENG-48.

Descriptors: *Groundwater movement, *Heat flow, *Flow, *Porous media, *Geologic fractures, Numerical simulations, Geohydrology, Fractures, Simulation.

A multiple interacting continua (MINC) method is presented, which is applicable for numerical simulation of heat and multiphase fluid flow in multidimensional, fractured porous media. This method is a generalization of the double-porosity concept. The partitioning of the flow domain into computational volume elements is based on the criterion of approximate thermodynamic equilibrium at all times within each element. The thermodynamic conditions in the rock matrix are assumed to be controlled primarily by the distance from the frac-

tures, which leads to the use of nested gridblocks. The MINC concept is implemented through the integral finite difference (IFD) method. No analytical approximations are made for the coupling between the fracture and matrix continua. Instead, the transient flow of fluid and heat between matrix and fractures is treated by a numerical method. The geometric parameters needed in a simulation are preprocessed from a specification of fracture spacings and apertures and the geometry of the matrix blocks. The numerical implementaiton of the MINC method is verified by comparison with the analytical solution of Warren and Root. Illustrative applications are given for several geothermal reservoir engineering problems. (Author's abstract)
W86-01138

ANALYTICAL REPRESENTATION OF THE VAN EVERDINGEN-HURST AQUIFER INFLUENCE FUNCTIONS FOR RESERVOIR SIMULATION,
Keplinger and Associates, Inc., Tulsa, OK.
J. R. Fanchi.
Society of Petroleum Engineers Journal, Vol. 25, No. 3, p 405-406, June, 1985. 1 Fig, 1 Tab, 5 Ref.

Descriptors: *Simulation analysis, *Aquifers, *Model studies, *Reservoirs, Mathematical analysis, Regression analysis, Unsteady state.

A widely used cost-effective means of representing an aquifer is to compute aquifer influx with an analytical model. Among the more popular analytical aquifer models in use today is the Carter-Tracy modification of the van Everdingen-Hurst unsteady-state aquifer influx calculation. An alternative approach to the table look-up method was derived using linear regression analysis to develop some simple analytical expressions for the van Everdingen-Hurst aquifer influx influence functions. Regression results are presented for a variety of aquifer radius/reservoir radius ratios. Besides simplifying the programming effort, the computer work is lessened because it is no longer necessary to perform a table look-up. The derivative of dimensionless pressure with respect to dimensionless time is obtained directly from differentiation of the regression equation for dimensionless pressure by dimensionless time. This avoids the necessity of performing a numerical differentiation and ensures that a mathematically smooth function is always used. The regression equations are designed for use in reservoir engineering applications, especially reservoir simulation. (Collier-IVI)
W86-01139

CONSIDERATIONS ON WATER, OIL AND AIR IN POROUS MEDIA,
Electrowatt Engineering Services Ltd., Zurich (Switzerland).
For primary bibliographic entry see Field 5B.
W86-01176

CALIBRATION OF A MASS TRANSPORT MODEL USING ENVIRONMENTAL TRITIUM,
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 5B.
W86-01289

RESPONSE OF GROUNDWATER LEVELS TO RAINFALL AND TO LEAF GROWTH OF FARM PLANTATIONS NEAR SALT SEEPS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Groundwater Research.
E. F. Biddiscombe, A. L. Rogers, H. Allison, and R. Litchfield.
Journal of Hydrology, Vol. 78, No. 1/2, p 19-34, May, 1985. 8 Fig, 1 Tab, 16 Ref, 1 Append.

Descriptors: *Groundwater level, *Rainfall, *Leaves, *Growth, *Salt seeps, *Western Australia, *Australia, Deforestation, Reforestation, Revegetation, Water table, Salinity.

Clearing of native forest has caused a rise in soil water tables and secondary salinization in south Western Australia. An experiment in reclamation began in May 1976 with the replanting of tree vegetation near salt seeps. Spectral analysis was used to relate the subsequent changes in static water levels of the groundwater to rainfall input and progressive leaf area index of two plantations on a single subcatchment. The upslope static water levels lagged the seasonal rainfall by 3-4 months, whereas the midslope levels lagged rainfall by approximately 1 month. Increasing leaf area of the plantations corresponded to decreasing groundwater levels in their vicinity. (Author's abstract)
W86-01290

SALT-WATER-FRESHWATER TRANSIENT UPCONING - AN IMPLICIT BOUNDARY-ELEMENT SOLUTION,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 5B.
W86-01291

MODELLING NON-POINT SOURCES OF NITRATE POLLUTION OF GROUNDWATER IN THE GREAT OUSE CHALK, U.K.,
Birmingham Univ. (England). Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W86-01294

FLOW IN A LIMESTONE AQUIFER AS DETERMINED FROM WATER TRACING AND WATER LEVELS IN WELLS,
Kentucky Univ., Lexington. Dept. of Geology.
J. Thrailkill.
Journal of Hydrology, Vol. 78, No. 1/2, p 123-136, May, 1985. 3 Fig, 29 Ref.

Descriptors: *Groundwater movement, *Aquifers, *Limestone, *Water level, *Tracers, *Wells, *Kentucky, *Karst hydrology, Geohydrology, Springs, Streams, Perched aquifers, Potentiometric level.

The Inner Bluegrass Karst Region of central Kentucky is a fluviokarst underlain by flat-lying slightly argillaceous limestones (Ordovician). Water tracing and field observations have shown the aquifer to be divisible into groundwater basins and intervening interbasin areas. Flow in groundwater basins is in a dendritic system of solution conduits at depths as great as 35 m beneath the surface which often passes beneath surface divides to emerge at low-level springs, in contrast to interbasin areas in which the flow is shallow and generally parallels surface slopes. The availability of relatively dense water-level data in an area in which a number of water traces had been conducted allowed a comparison between the configuration of the potentiometric surface and water tracing data. The potentiometric surface map was generally consistent with the location of groundwater basins and interbasin areas. In addition, water levels near streams were found to be controlled by the stream and a few wells indicated perched aquifers. The potentiometric surface, however, failed to show narrow groundwater basins and did not adequately indicate groundwater flow directions previously established by water tracing. Although well data may furnish valuable supplemental information, water tracing is necessary to determine adequately subsurface flow directions in the region and in similar karst aquifers elsewhere. (Author's abstract)
W86-01296

HYDROLOGY OF BANK GROUNDWATER WITHDRAWALS IN THE NETHERLANDS,
Ministerie van Volksgezondheid en Milieuhygiene, Leidschendam (Netherlands).
For primary bibliographic entry see Field 4B.
W86-01298

QUALITY OF WATER IN AN AQUIFER AND ITS MANIFESTATION IN PUMPING WELLS,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Fisica.
S. Gaona-Vizcayno, T. Gordillo De A., and R. N. Farvolden.
Journal of Hydrology, Vol. 78, No. 1/2, p 165-181, May, 1985. 11 Fig, 1 Tab, 9 Ref.

Descriptors: *Water quality, *Aquifers, *Groundwater contamination, *Pumping wells, *Mexico, Water temperature, Conductivity, Wells, Water sampling.

An analysis of the water flow under pumping stress in simple stratified aquifers, and field measurements of water quality from three sites in Mexico demonstrate the kind of information that can be obtained by observing water-quality changes (temperature and electrical conductivity) with time in a pumped well. Both short-term (hours) and longterm (years) changes were recorded. Water-quality changes provide information on the water quality near and far from the pumping well, and in some cases, the relative position within the aquifer of zones of different water quality. If changes in water quality are observed for different times after the well has been in production, then zonal changes in relative yield or quality may be detected. In the cases described in the paper, a representative sample of the aquifer in which the well is screened does not necessarily indicate the quality of water that will be produced over either the short or long term. In this case the term 'representative sample' is misleading. Short-term water-quality changes should be considered in setting operating parameters for optimal water quality. (Author's abstract)
W86-01299

DECREASE OF HYDRAULIC CONDUCTIVITY IN SAND AT THE INTERFACE BETWEEN SEAWATER AND DILUTE CLAY SUSPENSIONS,
Weizmann Inst. of Science, Rehovoth (Israel).
L. C. Goldenberg.
Journal of Hydrology, Vol. 78, No. 1/2, p 183-199, May, 1985. 5 Fig, 2 Tab, 44 Ref.

Descriptors: *Permeability coefficient, *Saline-freshwater interface, *Coastal aquifers, *Clay minerals, Aquifers, Seawater, Groundwater movement, Deflocculation, Sand.

The hydraulic conductivity of the seawater-fresh groundwater interface zone in coastal aquifers may decrease due to deflocculation and dispersion of small amounts of arrangements of reactive clay minerals that exist in the rock. This dispersed phase may influence to a large degree the connectivity between the conducting pores of a sediment. A reduction of hydraulic conductivity by 2-3 orders of magnitude was observed in analytically pure sand as well as in shore sand packed in columns when an interface between seawater and a dilute suspension of montmorillonite was created. The experiments were done by introducing suspensions of 5, 15, 30 and 60 mg/l of montmorillonite to columns in which a flow of seawater has previously been established. An amount of clay as small as 0.005% was involved in the creation of low permeability. The proposed model for explanation of the observed reduction of hydraulic conductivity assumes that at a certain stage the fluid begins to behave as a non-Newtonian fluid since loose networks of clay particles trap approximately 99% of water, causing stoppage in the 'bottlenecks' of the porous medium. As a consequence the overall sediment behaves as a 'Bingham system', with a yield stress. Coating of sand grains with clay is also assumed to occur in the case of concentrated suspension. (Author's abstract)
W86-01300

GRADIENT CONTROLLED CAVES, TRAPPER-MEDICINE LODGE AREA, BIGHORN BASIN, WYOMING,
Wyoming Univ., Laramie. Dept. of Geology and Geophysics.
P. W. Huntoon.
Ground Water, Vol. 23, No. 4, p 443-448, July-August, 1985. 6 Fig, 6 Tab. Office of Water Research and Technology, U.S. Department of the Interior, contract 14-35-000102145, project A-0340-WYO.

Descriptors: *Caves, *Geohydrology, *Trapper-Medicine Lodge Area, *Bighorn Basin, *Wyo-

ming, *Groundwater movement, Carbonates, Karst hydrology, Limestone, Permeability, Artesian basins, Hydraulic gradient.

Local steepening of hydraulic gradients dictate the locations where caves develop within a soluble rock sequence. An example of cave systems that fit this model are the extensive caves that have developed under canyons in the Trapper-Medicine Lodge recharge area where groundwater flow rates became maximized within the Madison carbonates during Cenozoic time. The Trapper-Medicine Lodge area is situated on the eastern perimeter of the Bighorn artesian basin, and serves as a recharge area for aquifers interbedded within the Paleozoic and Mesozoic section. The sediments dip gently westward at about six degrees in a homocline that is being stripped of its younger sediments by erosion. The large flow rates resulted directly from the superposition of steep local gradients on the groundwater circulation system as a consequence of the erosion of confining units in the region. Gradients within the Madison aquifer were steepest in the zones directly under and adjacent to the canyon floors. Today, average gradients in the Trapper-Medicine Lodge area are 400 ft/mi as compared to 40 ft/mi in the adjacent parts of the Bighorn basin. The permeabilities of the Madison aquifer at the time of exposure were small and were similar to those found in the unfaulted interior of the Bighorn basin. However, enhanced groundwater circulation rates through the carbonate rocks proximal to the canyons accelerated dissolution along joints in those zones. As this preferential circulation-dissolution process proceeded, caves began to develop and become highly localized under and adjacent to the entrenching canyon floors. This is exactly the condition that is found today, except caves observed today are the youngest in the system because older upper level networks have been eroded away as the canyons have deepened. The cave forming process in this area is gradient controlled, a conclusion that has possible applicability elsewhere. (Collier-IVI)
W86-01305

INTERPRETATION OF DUG WELL PERFORMANCE USING A DIGITAL MODEL,
Institute of Geological Sciences, London (England). Hydrogeology Unit.
A. R. Lawrence.
Ground Water, Vol. 23, No. 4, p 449-454, July-August, 1985. 6 Fig, 2 Tab, 6 Ref.

Descriptors: *Model studies, *Wells, *Groundwater flow, Water table, Permeability, Aquifer storage, Water storage, Aquifers, Chakpatni Test, Transmissivity.

A digital model is shown to successfully simulate the distribution of head in and around a large-diameter well during both the pumping and recovery phases. Existing methods of analysis are unsuitable for the case as described where the well partially penetrates a layered aquifer of low permeability. The weathered zone behaves as a layered aquifer. There is a time lag between an observable response in the water table and a decline in the head of the underlying, more permeable layer. After a dug well has been pumped in an aquifer of low permeability, the water level in the well rises while the cone of depression continues to expand, with a consequent fall in the water level around the well. The maximum radius of influence can be in excess of 50 m which may be reached several hours after pumping has stopped. This complex flow situation makes analysis by standard drawdown-time methods invalid. The dug well recovery rate is sensitive to the permeabilities of the fast layer but less sensitive to the aquifer storage coefficient and the permeability of the slow layer. The vertical component of ground water flow into a dug well can be important. The computed and observed water level recovery data for the dug well appears to lie as a straight line on a log-linear plot. This may be true only where the main producing zone is not dewatered and the transmissivity of the aquifer remains constant throughout the test. The Chakpatni test was modeled satisfactorily, and the computed aquifer parameters agree reasonably well with the result from a slug injection test. The hydraulic behavior of the dug well is now sufficiently well understood for investigation of optimum well design to be undertaken. (Baker-IVI)
W86-01306

SOME COMPUTATIONAL EXPERIENCES USING EMBEDDING TECHNIQUE FOR GROUND-WATER MANAGEMENT,
Nevada Univ., Reno. Dept. of Civil Engineering.
Y. K. Tung, and C. E. Koltermann.
Ground Water, Vol. 23, No. 4, p 455-464, July-August, 1985. 6 Fig, 18 Ref. Office of Water Research and Technology project A-103-NEV.

Descriptors: *Embedding techniques, *Groundwater management, *Model studies, *Las Vegas Valley aquifer, Hydraulic head, Pumpage, Groundwater movement.

A distributed parameter groundwater management model was developed using finite-difference approximations of the governing differential equation for groundwater flow in a confined aquifer. The resulting system of simultaneous equations was embedded in an optimization model, which used hydraulic heads and pumpages as unknown state variables and decision variables, respectively. The model was applied to several hypothetical examples of varying size and complexity and to one real-world example, the Las Vegas Valley aquifer. The grid spacing, time increment, bounds placed on pumpage, and the number of constraints were found to affect not only the execution time, but also whether the model would execute at all. In order to accommodate long-term management goals, a lumped transient model should be used which incorporates all time periods the model encompasses. Some objective functions, such as the maximization of the head, can be executed in a stepwise manner in which the final heads from the current period are used as the initial heads for the next period. The embedding technique proved useful for small management problems, but had numerical difficulties with the large real-world problems of considerable heterogeneity. Unless the embedding technique can become computationally efficient and stable, it should be bypassed in favor of the response matrix approach. (Author's abstract)
W86-01307

MODEL STUDY OF SALT-WATER INTRUSION TO A RIVER USING THE SHARP INTERFACE APPROXIMATION,
Kansas State Geological Survey, Lawrence.
C. D. McElwee.
Ground Water, Vol. 23, No. 4, p 465-475, July-August, 1985. 8 Fig, 1 Tab, 13 Ref.

Descriptors: *Saline water intrusion, *Rivers, *Water quality, *Smoky Hill River, *Kansas, *Model studies, *Saline-freshwater interface, Geochemistry, Geohydrology, Aquifers, Water pollution prevention.

Between Salina and Enterprise, Kansas, the salinity of the Smoky Hill River increases sharply. As a result, the river downstream at various times exceeds the recommended drinking-water-quality standards for chloride. The Smoky Hill and Kansas Rivers are important sources of water for several population centers in eastern Kansas; therefore, this problem has an impact on a significant part of the Kansas population. The source of the saline water is predominantly from groundwater dissolution of the Hutchinson Salt Member of the Wellington Formation of Permian age. The dissolution of the salt has caused a north-south trending collapsed zone called the Wellington aquifer to occur along the present eastern extent of the salt. A confining shale layer exists between the Smoky Hill alluvium and the Wellington aquifer in most areas. However, between New Cambria and Solomon, Kansas, the layer is thin and fractured, allowing the salt water to move up into the alluvium. The steady-state model presented in this study indicates that the saline water layer of the alluvium in the Smoky Hill River valley should be in an unstable condition near the river. This indicates that unstable interface upconing should be a dominant mechanism for supplying salt water to the river system. The time-varying model shows that the response of the chloride discharge to a flood event can be qualitatively explained by the unstable interface upconing mechanism. As the river stage rises, the saline water intrusion declines. As the river stage declines, the saline water intrusion increases beyond its normal value and subsides to the normal value over the period of a few months if no new flood events occur. During rising river stage, the river is supplying the groundwater system, and the saline water intrusion or unstable upconing is shut off. During falling river stage, bank storage and perhaps an elevated water table cause the fresh groundwater discharge to be greater than normal, which in turn causes greater than normal saline water intrusion. In addition, the time-varying model shows that several years would elapse before significant benefit would be seen in the river system from a proposed Wellington aquifer relief-well scheme. (Author's abstract)
W86-01308

LABORATORY INVESTIGATION AND ANALYSIS OF A GROUND-WATER FLOWMETER,
Auburn Univ., AL. Dept. of Civil Engineering.
J. G. Melville, F. J. Molz, and O. Guven.
Ground Water, Vol. 23, No. 4, p 486-495, July-August, 1985. 14 Fig, 8 Ref. EPA contract CR810704-01-0.

Descriptors: *Groundwater movement, *Flowmeters, *Measuring instruments, Aquifers, Permeability coefficient.

An idealized analysis is presented which clarifies the hydrodynamic and thermodynamic principles of the ground water flowmeter system, model 30L, (K-V Associates Inc.). Laboratory experimental procedures and results are then discussed. The influence of hydraulic conductivity contrast between the aquifer and backfill materials is also analyzed theoretically and studied experimentally. Measurements were made of the influence of slotted pipe schedule, slot orientation, backfill materials, endcap bags, isolated regions of high hydraulic conductivity and channelization near the slotted pipe wall. The basic instrument response is linear, consistent and predictable qualitatively in a lab environment. Very small channelization around a slotted pipe casing or between the slotted pipe and the probe endcap can invalidate the instrument response. Additional potential complications arise due to unknown permeability contrasts between the aquifer matrix and the material used to backfill around the probe. (Baker-IVI)
W86-01310

MOVEMENT OF VOLATILE ORGANICS THROUGH A FRACTURED ROCK AQUIFER,
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W86-01311

SIMULATED SALT-WATER MOVEMENT IN THE NAKHON LUANG AQUIFER, BANGKOK, THAILAND,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
A. Das Gupta.
Ground Water, Vol. 23, No. 4, p 512-522, July-August, 1985. 10 Fig, 1 Tab, 18 Ref.

Descriptors: *Aquifers, *Groundwater movement, *Bangkok, *Thailand *Nakhon Luang, *Saline water intrusion, Aquifer, Model studies, Mathematical models, Connate water, Simulation.

An attempt was made to simulate the trend of salt-water movement in Nakhon Luang aquifer with the aid of a mathematical model considering the appropriate boundary and initial conditions and parameter values inferred from available field information on salt contamination. The evaluation indicated that connate-water bodies are the predominant source of contamination. Analytical and numerical modeling procedures were used to delineate approximately the extent of the contaminating source and to predict the rate of encroachment of contamination with various assumed future pump-

ing patterns. The contaminating source is widespread and is located on the western side of the Chao Phraya River. With the present rate of pumping, the rate of encroachment is greatest from the northwest direction towards to the main pumping center. Estimated rates of encroachment of the contaminated body along four directions under three hypothesized pumping schemes provide proper guidelines in planning an efficient monitoring network. The possibility of contamination due to vertical leakage of salt water from the Bangkok Aquifer through the abandoned deep wells needs further investigation. (Baker-IVI)
W86-01313

2G. Water In Soils

USE OF COMPUTER-ASSISTED TOMOGRAPHY TO DETERMINE SPATIAL DISTRIBUTION OF SOIL WATER CONTENT,
Western Australia Univ., Nedlands. Dept. of Soil Science and Plant Nutrition.
J. M. Hainsworth, and L. A. G. Aylmore.
Australian Journal of Soil Research, Vol. 21, No. 4, p 435-43, 1983. 4 Fig, 1 Tab, 19 Ref.

Descriptors: *Computer assisted tomography, *Soil water, Gamma radiation, X-rays, Soil-water-plant relationships, Measurement instrumentation, Spatial distribution.

The potential of computer assisted tomography (CAT) for direct and repetitive measurement of spatial distributions of soil water content in a non-destructive manner was investigated. A commercially-produced X-ray CAT scanner and a conventional gamma scanner were used to study three experimental situations: a concentric ring pot uniformly packed with soil and each ring equilibrated at a given water content; an artificial root (alundum tube); and water uptake by a single root. Results suggest that CAT scanning can be used to determine spatial changes in soil water content with adequate resolution for soil-plant studies. The technique can clearly be used to resolve spatial changes in soil water content with time. Gamma scanning systems are considerably cheaper to construct than commerically available X-ray systems and are likely to be more accessible to workers in this field. The experiments indicate that the application of CAT to soil-plant studies possesses an extremely exciting potential. (Moore-IVI)
W86-01027

MOVEMENT OF CACL2 SOLUTIONS IN AN UNSATURATED CLAY SOIL: THE EFFECT OF SOLUTION CONCENTRATION,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
W. J. Bond, B. N. Gardiner, and D. E. Smiles.
Australian Journal of Soil Research, Vol. 22, No. 1, p 43-58, 1984. 6 Fig, 2 Tab, 28 Ref.

Descriptors: *Calcium chloride, *Solute transport, *Unsaturated flow, *Clays, Salts, Concentration, Soil water, Exclusion volume, Salt front, Wetting front.

The effect of solution salt concentration on the movement of calcium chloride during unsteady, unsaturated flow in a structurally stable, calcium-saturated, heavy clay soil is described. Solutions of CaCl2 were supplied at a head of -10 mm of water to horizontal columns of soil containing solution with a different concentration of CaCl2 at a low water content. The measured apparent solution concentrations near the inlet were less than the applied solution concentrations, and the identifiable salt front moved more rapidly than the 'piston-front' of the water. The magnitude of both effects was dependent on solution concentration. The observations are consistent with exclusion of anions from the diffuse double layer at the clay surface. The relationship between exclusion volume (or inaccessible water content) and solution concentration, obtained from the measurements, was affected by the interaction of double layers at low solution concentration and may also be affected by water content. An expression was derived which permits prediction of the position of the salt front from the properties of the initial and invading solutions. (Author's abstract)
W86-01029

MOISTURE MEASUREMENT IN A SWELLING CLAY SOIL USING NEUTRON MOISTURE METERS,
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
N. S. Jayawardane, W. S. Meyer, and H. D. Barrs.
Australian Journal of Soil Research, Vol. 22, No. 2, p 109-117, 1983. 6 Tab, 14 Ref.

Descriptors: *Soil water, *Neutron moisture meters, *Clays, Swelling soils, Soil texture, Density, Mathematical equations, Calibration, Measurement instrumentation, Irrigation effects, Water balance.

Neutron meters were calibrated for moisture determination in a layered swelling soil, showing changes in both swelling characteristics and texture with depth. The bulk density-moisture content relationship of each layer determined from small soil cores agreed with those predicted from in-situ swelling measurements taken during a previous study. The precision of calibration of two neutron meters were markedly improved by correcting for textural and bulk density changes with depth. The regressions of total moisture content on corrected neutron ratios were similar for the two moisture meters and comparable to those obtained for similar soils in previous studies provided that the same calibration techniques were used. For moisture determination in the field, separate calibration equations of volummetric moisture content against neutron ratios were required to account for the individual bulk density-moisture content relationship of each soil layer. The calibration equation for the surface layer had a markedly lower calibration coefficient and a much higher intercept constant than for the subsoil. Measured changes in soil moisture following irrigation using the above calibration equations of the neutron moisture meter agreed closely with values predicted by water balance within a large soil core in a lysimeter. (Author's abstract)
W86-01030

EFFECTS OF WATERLOGGING AND SUBSEQUENT DRAINAGE OF A PASTURE SOIL ON PHOSPHATE SORPTION, EXTRACTABLE PHOSPHATE AND OXALATE-EXTRACTABLE IRON,
New South Wales Dept. of Agriculture, Rydalmere (Australia). Biological and Chemical Research Inst.
For primary bibliographic entry see Field 2K.
W86-01038

UNSATURATED AND SATURATED FLOW THROUGH A THIN POROUS LAYER ON A HILLSLOPE,
Western Australia Univ., Nedlands. Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W86-01073

SIMILARITY SOLUTION OF OVERLAND FLOW ON PERVIOUS SURFACE,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W86-01092

SOME HYDRAULIC PROPERTIES OF SANDY-SILTY NORWEGIAN TILLS,
Norges Landbrukshoegskole, Aas. Dept. of Geology.
S. Haldorsen, P. D. Jenssen, J. C. Koler, and E. Myhr.
Acta Geologica Hispanica, Vol. 18, No. 3/4, p 191-198, 1983. 7 Fig, 25 Ref.

Descriptors: *Tills, *Soil hydraulic properties, *Norway, Interstitial water, Soil permeability, Soil water, Groundwater level, Capillary conductivity.

Norwegian tills are usually coarse. The saturated water movement is mainly concentrated along fractures, fissures and sorted sediment zones. The studies indicate that less than 10% of the water drains through the pore system of the till matrix. There is no marked correlation between the grain-size composition of the till and the saturated permeability. Homogeneous Norwegian tills may form important conduits of capillary water transport from the groundwater level to the vegetation during dry summers. This is mainly because the tills are dominated by equidimensional minerals which form an open pore system and because the groundwater level in many cases is situated at shallow depths. (Author's abstract)
W86-01111

INFILTRATION FROM A TRICKLE SOURCE IN A HETEROGENEOUS SOIL MEDIUM,
California Univ., Davis. Dept. of Land, Air and Water Resources.
S. A. Taghavi, M. A. Marino, and D. E. Rolston.
Journal of Hydrology, Vol. 78, No. 1/2, p 107-121, May, 1985. 9 Fig, 1 Tab, 21 Ref. CSRS project CA-D*-LAW-4350-H.

Descriptors: *Infiltration, *Trickle irrigation, *Soil water, Irrigation, Unsaturated zone, Irrigation efficiency, Irrigation practice.

Galerkin's weighted residual method was used to numerically solve the two-dimensional nonlinear partial differential equation that describes the transient movement of water in an unsaturated porous medium. The model which had been successfully used to simulate the transient moisture movement in a homogeneous soil medium was applied in a newer version to one-dimensional vertical and two-dimensional steady-state moisture flow in a heterogeneous soil medium. The computed results in the vertical infiltration problem compared well with results obtained from a Hermitian finite-element model. The results of the steady-state pressure head distributions also compared well with experimental data from a trickle irrigation source. The advantages of the existing model to other simulation models are its ability to deal with moisture movements through a very dry soil environment in a homogeneous or heterogeneous medium, as well as its ability to treat the irregularly shaped flow regions which are usually difficult to model with other numerical models. (Author's abstract)
W86-01295

ESTIMATING VERTICAL SOIL MOISTURE FLUX AT A LAND TREATMENT SITE,
California Univ., Santa Cruz. Dept. of Applied Science.
S. J. Dreiss, and L. D. Anderson.
Ground Water, Vol. 23, No. 4, p 503-511, July-August, 1985. 9 Fig, 1 Tab, 12 Ref, 1 Append.

Descriptors: *Soil water, *Land disposal, *Percolation, Path of pollutants, Soil saturation, Estimating, Soil matric suction.

In land treatment projects where wastes sludges or fertilizers are applied to the ground surface, these estimates are particularly important because subsurface water movement is the primary means of contamination migration. A sludge land treatment project that was the motivation for making percolation estimates is reviewed. The method used to compute percolation is presented and the results of the computations are discussed. Use of the zero flux plane hypothesis gives reasonable estimates of cumulative seasonal percolation when weekly measurements of moisture content and matric suction are used. A detailed description of the spatial variability of K-sat is not warranted with this method unless K-sat is very small. Soil-water percolation through marine terrace sediments in central California varies an order of magnitude between years of high and low rainfall. (Baker-IVI)
W86-01312

2H. Lakes

DYNAMICS OF COLONIZATION IN AN EXPERIMENTAL CHANNEL, FED BY THE PO RIVER WATERS,
Milan Univ. (Italy). Ist. di Biologia.
B. Rossaro.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2102-2105, 1985. 1 Tab, 6 Ref.

Descriptors: *Po River, *Italy, *Species composition, *Periphyton, Ecological distribution, Seasonal variation, Water temperature.

Seasonal factors, more than substrate exposure time, seem to control the dynamics of invertebrate colonization of air-dried Typha latifolia stems and leaves. Typha (about 500 g dry weight) was in baskets suspended in an artificial channel; the artificial channel was 22 m long, 60 cm wide, and fed by the waters of the Po River (Italy) at a constant flow rate of 1-2 cm/sec and water depth of 1 cm. Temperature, river discharge, photoperiod, dissolved oxygen, and substrate exposure time were correlated with the abundances of taxa found, after log (x+1) transformation. Water temperature, more than substrate exposure time, accounted for fluctuations in abundance. Some taxa responded to photoperiod more than water temperature. Only Bryozoa were dependent on substrate exposure time. Microhabitats provided by Typha allowed colonization by Glyptotendipes paripes. Most of the other taxa were periphyton dwellers and more or less euryecious; their colonization was mainly related to drift composition. The most abundant taxa were Naididae (Stylaria and Chaetogaster) and Chironomidae (Paratanytarsus mediterraneus, Cricotopus sylvestris, G. paripes); the gastropod Viviparus ater and the amphipod Echinogammarus stammeri were the most important in terms of biomass. (Rochester-IVI)
W86-00920

ABOUT A SOURCE OF NUTRIENTS IN THE TROPICAL RIVER RAJANG (N BORNEO) IN RELATION TO FUTURE IMPOUNDMENT,
Forschungsinstitut und Natur-Museum Senckenberg, Frankfurt am Main (Germany, F.R.).
For primary bibliographic entry see Field 6G.
W86-00921

DRIFT IN HAWAIIAN STREAMS,
Brigham Young Univ., Provo, UT. Dept. of Zoology.
J. R. Barnes, and D. K. Shiozawa.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2119-2124, 1985. 2 Fig, 1 Tab, 31 Ref.

Descriptors: *Aquatic drift, *Hawaii, *Streams, *Macroinvertebrates, Caddisflies, Turbellaria, Oligochaetes, Harpacticoida, Crustaceans, Animal behavior.

Macroinvertebrate drift patterns were studied in four Hawaiian streams. During sampling sunset was between 19:00 and 20:00 hr and sunrise between 06:00 and 07:00 hr; sampling lasted for 24 hr, and employed 30 x 10 cm drift nets with 110 micrometer mesh netting. Turbellaria, Oligochaeta, Chironomidae, Trichoptera, Decapoda, and Harpacticoida were collected in significant densities. Turbellarians were collected only in Waiahole stream, on the island on Oahu; they exhibited a typical bigeminous drift pattern, with the initial drift peak occurring just after sunset and a secondary peak a few hours before sunrise. Oligochaetes occurred in the drift of Paakea and Waiohue streams (on Maui island) and Hanakapiai (Kauai island), and Waiahole stream. No diel patterns were apparent on Maui, but a bigeminous peak was recorded for the Hanakapiai oligochaetes. The major peak occurred shortly after sunset and a secondary peak occurred just before sunrise. Chironomid drift from both Paakea and Waiohue streams showed no diel behavioral drift pattern. Midges in Hanakapiai drifted with an alterans pattern. Cheumatopsyche analis, and introduced trichopteran, had a unimodal peak just after sunset in Waiohue, Hanakapiai, and Waiahole and a bigeminous pattern in Paakea. A juvenile atyid shrimp, which was collected in both Paakea and Waiohue, had two color phases in the drift in Paakea. The light shrimp had a bigeminous pattern whereas the dark shrimp had a unimodal nocturnal drift pattern peaking several hours after midnight. The harpacticoid copepod Nitocra spinipes was collected in the drift of Paakea, Waiohue, and Hanakapiai. Those in Paakea followed the alterans pattern, those in Hanakapiai followed the bigeminous pattern, and the Waiosue population had an alterans pattern except for a daytime peak at 16:00, which could have been due to catastrophic drift. (Rochester-IVI)
W86-00922

LIMNOLOGY OF A NATURALLY ACIDIC TROPICAL WATER SYSTEM IN AUSTRALIA; I. GENERAL DESCRIPTION AND WET SEASON CHARACTERISTICS,
AVCA, Sydney (Australia).
A. W. Morley, T. E. Brown, and D. V. Koontz.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2125-2130, 1985. 2 Fig, 2 Tab, 3 Ref.

Descriptors: *Jabiluka, *Magala River, *Australia, *Northern Territory, *Limnology, *Tropical regions, *Seasonal variation, Ecological effects, Mining, Billabongs, Fishkill, Mussels, Water pollution effects.

Major changes in water quality occur in the Magela Creek (Northern Territory of Australia) during the dry-to-wet season; as a consequence fish and other biota are significantly affected. The region in which the Magela Creek is located experiences a distinct wet and dry season, with 97% of the 1,530 mm annual rainfall occurring in the wet season (October-May). Average effective evaporation exceeds rainfall by approx 700 mm, a circumstance which is responsible for the formation of a series of discrete billabongs (water holes) of varying sizes throughout the area during the dry season. During the wet season the Magela floodplain is a continuous body of water 2-5 m deep. The waters of Magela Creek are naturally acidic and very soft, with low levels of nutrients. Regional climatic changes induce perturbations in water quality, as does ingress of groundwater into floodplain billabongs. Studies in 1979-80, 1980-81, 1981-82, and 1982-83 revealed fish kills of varying degrees of severity. In some cases acidic water with elevated aluminum levels was present at the time of the fish kills, but other kills had no obvious cause. Freshwater mussels (Velesunio angasi) also died in one of these events. The losses of biota were associated with the onset of flooding. After the floodplain became completely covered with water, water quality was excellent. Anthropogenic changes in water quality that may occur when Jabiluka uranium mining operations commence will be difficult to separate from the significant natural changes. (Rochester-IVI)
W86-00923

LIMNOLOGY OF A NATURALLY ACIDIC TROPICAL WATER SYSTEM IN AUSTRALIA; II. DRY SEASON CHARACTERISTICS,
BCLV, Morwell (Australia).
T. E. Brown, A. W. Morley, and D. V. Koontz.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2131-2135, 1985. 2 Fig, 3 Ref.

Descriptors: *Magela Creek, *Australia, *Northern Territory, *Limnology, *Acid lakes, *Seasonal variation, Ecological effects, Billabongs, Water chemistry, Fishkills, Water quality.

The degrees of change in water quality occurring in billabongs (water holes) of the Magela Creek floodplain (Australia) by the end of the dry season is primarily a function of the duration of the rain-free period, but depends additionally on other factors. Water chemistry changes correlate with fishkills in some cases, but some fishkills have occurred without apparent cause. The dry season in this area is characterized by high temperatures and the absence of rainfall. By the end of the dry season surface water is lacking except for about 10 billabongs. Although the billabongs vary in individual characteristics, two types are recognizable. Type I billabongs have steep sides; solute concentration at the end of the dry seasons is 3-5x that at the end of the preceding wet season. Type II billabongs have shallow sloping banks on at least one side, with the result that surface area:water depth:total volume ratios change with time during recession of the water as the dry season progresses. Solute concentration increases up to 10-fold have been observed in Type II billabongs. A comparable depth reduction changes concentration of solutes much more in a type II than a type I billabong. Some water quality parameters increase in concentration during the dry season more than can be accounted for by evaporation alone (ie, manganese, sulfate, and potassium, and some others in type II billabongs). With establishment of regular rain, flooding of the Magela Creek floodplain enables each of the billabongs to become diluted and/or flushed with streamwater, a mechanism that halts the deterioration in water quality. Without such annual regeneration, the ecology of the billabongs probably would be irreversibly altered. (Rochester-IVI)
W86-00924

ZOOPLANKTON OF THE DARLING RIVER SYSTEM, AUSTRALIA,
Adelaide Univ. (Australia). Dept. of Botany.
R. J. Shiel.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2136-2140, 1985. 3 Fig, 12 Ref.

Descriptors: *Australia, *Darling River, *Zooplankton, Rotifers, Turbidity, Species composition, Water quality, Animal behavior.

The mainstream Darling River, Australia, transports a complex, rotifer-dominated plankton southward for more than 2,700 km from tropical Australia, with inoculations of 'temperate' species from westward-flowing headwater rivers. Few significant reservoirs and high abiogenic turbidity (80-350 NTU, depth < 2 cm) characterize this system. Eighty species of Rotifera were identified. Warm stenotherms predominate, with brachionids the most abundant family. Commonly, 3-6 spp of Brachionus and 4-7 spp or Keratella occur in a single collection, and they dominate numerically. Of 21 cladoceran taxa identified from the river, only Bosmina meridionalis and Cerdiodaphnia cornuta were common. Cyclopoid copepods (Eucyclops, Mesocyclops) were rare; calanoids (Boeckella triarticulata, Calamoecia lucasi) were seasonal in Menindee Lakes, and also were flushed into mainstream flows, principally in naupliar/copepodite stages. Each influent contributes a species-rich plankton, the dominants of which are dissimilar. For example, of 65 taxa identified in tow samples collected within 2 hr, 100 km apart, from the Gwydir River (31 spp, Shannon-Wiener H' = 3.90) and the Barwon River (34 spp, H' = 3.71), only 8 spp were shared. Plankton densities > 800/l were recorded in Lake Menindee in May 1983 after initial flood flows from the Darling River, with 400/l below the lake at Pooncarie, midway to the confluence with the Murray River. Possible evidence of adaptation at the specific level to extreme turbidity was observed in Daphnia carinata. A 3.00 mm specimen from the Menindee Lakes had an intersetule spacing of 0.875 + or - 0.04 micro-m, whereas a 3.3 mm specimen from the Mt Bold water-supply reservoir near Adelaide had a 0.262 + or - 0.01 micro-m spacing. Setal rows of the Darling system specimen were also more widely spaced, so that setules of parallel setae are not linked by hook-like tips. (Rochester-IVI)
W86-00925

MACROINVERTEBRATE COMMUNITY OF STONES IN AN AUSTRALIAN UPLAND STREAM,
Monash Univ., Clayton (Australia). Dept. of Zoology.
P. S. Lake, T. Doeg, and D. W. Morton.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2141-2147, 1985. 6 Fig, 1 Tab, 19 Ref.

Descriptors: *Macroinvertebrates, *Streambeds, *Australia, *Victoria, *Acheron River, *Stones, *Rocks, Seasonal variation, Species composition, Species distribution, Physicochemical characteristics, Cluster analysis.

Insects made up 95% of the fauna collected from stones sampled 10 times between February 1979 and March 1980 in the Acheron River, Victoria (Australia). During sampling the stream had low conductivity, pH from 7.5-8.0, and water temperature from 5.8-13.5 C. Depth of the stones in the stream did not vary significantly during the study, but current velocity did. Dominant orders collected were Plecoptera (16 spp), Trichoptera (14 spp), and Diptera (12 spp). Four groups with different seasonal abundance trends were identified: (1) ten taxa with a maximum abundance in early- to mid-summer, (2) three taxa peaking in abundance in autumn, (3) eight taxa with abundance peaks in winter, and (4) at least 6 spp that occurred in fairly constant numbers throughout the sampling period. Collectors, principally collector-gatherers rather than collector-filterers, clearly comprised the dominant group at all sampling times, although no clear trends were evident with respect to changes in their density with time. Shredders occurred at the lowest densities in spring-early summer and attained peak densities in late summer-autumn, which have corresponded with the peak in litter fall of the catchment's eucalypt forest and to the low current velocities in late summer. On every sampling occasion the number of species in the community was not significantly different from the expected value of 32. Similarly, no significant difference was observed over time in areal species density (number of species per stone/surface area), but densities of animals (number of animals per stone/surface area) were highest (1,024/sq m) in mid-winter and lowest (282 animals/sq m) in late summer. Clustering analysis grouped collections of June, July, August, September, and November as one group, but the two summer assemblages were separated both from this winter-spring group and from each other. (Rochester-IVI)
W86-00926

BENTHIC FAUNAS AND FOOD RESOURCES OF INSECTS IN SMALL NEW ZEALAND STREAMS SUBJECTED TO DIFFERENT FORESTRY PRACTICES,
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 4C.
W86-00927

LIMNOLOGICAL INVESTIGATION OF THE RIVERS URACOA, YABO, MORICHAL LARGO AND CLARO IN THE EASTERN PLAINS OF VENEZUELA,
Fundacion La Salle de Ciencias Naturales, San Felix (Venezuela). Estacion Hidrobiologica de Guayana.
L. Sanchez, E. Vasquez, and L. Blanco.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2153-2160, 1985. 6 Fig, 1 Tab, 16 Ref.

Descriptors: *Uracoa River, *Yabo River, *Morichal Largo River, *Claro River, *Venezuela, *Physicochemical characteristics, *Phytoplankton, *Zooplankton, Species composition, Rotifers, Hydrogen ion concentration, Dissolved oxygen, Color, Copepods, Cladocerans, Aquatic insects.

Physico-chemical parameters, phytoplankton, zooplankton, and macrophytic vegetation of four rivers in the eastern plains of Venezuela were sampled at 8 stations. Overall, water temperatures ranged from 25.0-30.0 C, pH ranged from 4.9-7.1, dissolved oxygen (DO) ranged from 1.4-9.2 mg/l, and average values of color ranged from 14-40 Pt-Co units. Thirty-seven genera of phytoplankton occurred in the Uraco, 31 in the Yabo, 40 in the Morichal Largo, and 27 in the Claro; Chlorphyta and Bacillariophyta were the dominant groups. Asterionella, Fragilaria, Surirella, Melosira, Tabellaria, and Navicula were the most frequently recorded genera. Maximum phytoplankton abundance coincided with increased pH and DO values, whereas low phytoplankton numbers coincided with low values of these parameters. In order of predominance, rotifiers, copepods, cladocerans, and insect larvae were the dominant zooplankton groups. The rotifers were represented by 17 taxa in six eurotatorian families. No clear pattern of variations in rotifer dynamics was seen. Of the different rotifers, Keratella americana was most dominant, with a maximum density of 56 organisms/l noted in March in the Uracoa River. At the same station and in the same month, Brachionus, the second most dominant genus, was found at 36 organisms/l. Copepods had a maximum density (28 organisms/l) on the Yabo River in May, and cladocerans had their greatest abundance (18 organisms/l) in May and insect larvae had their greatest abundance (22 organisms/l) in September. Macrophyte cover was relatively high in the borders of the river channel during the rainy season. Overall, 19 macrophyte families were represented in the vegetation sampled at all the stations. (Rochester-IVI)
W86-00928

RIVER TYPOLOGY OF SAO PAULO STATE, BRAZIL,
Instituto de Pesca, Santos (Brazil).
M. H. Maier, M. Takino, M. A. Basile-Martins, and M. N. Cipolli.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2161-2166, 1985. 1 Fig, 2 Tab, 5 Ref.

Descriptors: *River systems, *Sao Paulo State, *Brazil, *Physicochemical characteristics, Seasonal variation, Water temperature, Turbidity, Dissolved oxygen, Alkalinity, Conductivity, Silica, Iron, Chloride, Ammonia, Nitrites, Orthophosphate, Hydrogen ion concentration.

Characterization of seven rivers of Sao Paulo State, Brazil, was conducted based on physicochemical parameters sampled either on a short-term basis (June-September, Sapucai Guacu and Capivari), a long-term basis (a minimum of two complete seasonal cycles, Jaguari, Mogi Guacu, Piricicaba, and Jacare Pepira), or by both approaches (Ribeira de Iguape). Temperature, turbidity, dissolved oxygen, pH, alkalinity, conductivity, silica, iron, chloride, ammonia, nitrite, and orthophosphate were determined. The rivers could be divided (by cluster analysis) into two groups: AB, characterized by conductivity of 11-46 micro-Siemens/cm (micro-S) and alkalinity of 0.2-0.4 milliequivalents (m-eq)/liter, and CD, characterized by 55-82 micro-S/cm and 0.5-0.8 m-eq/l, respectively. Chloride values helped to identify the CD group (2.9-6.6 ppm), but for the AB group chloride results probably were distorted by the presence of sewage influx, particularly during July. Both the long-term investigation and the short-term one appeared adequate to characterize these lotic environments. (Rochester-IVI)
W86-00929

STRATIFICATION AND PRIMARY PRODUCTION IN A SMALL BRACKISH LAKE STUDIED BY CLOSE-INTERVAL SIPHON SAMPLING,
Abo Akademi, Turku (Finland). Dept. of Biology.
T. Lindholm, K. Weppling, and H. S. Jensen.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2190-2194, 1985. 6 Fig, 12 Ref.

Descriptors: *Stratification, *Primary production, *Brackish lakes, *Lake Holmsjon, *Aland, *Finland, Chemocline, Bacteria, Photosynthetic bacteria, Phosphorus, Ammonia, Nitrogen.

The importance of chemocline primary production was demonstrated in Lake Holmsjon, Aland (southwestern Finland), a basin incompletely isolated from the Baltic Sea and exhibiting temporary meromixis. A new in-situ incubator, with spirally-arranged arms at 5 cm depth intervals, was used for primary production measurements in the bacterial plate. Due to stratification, the water below 3.5-4 m was anoxic in both summers studied. The high clarity of water (Secchi depth: 2-4 m) permitted phototrophic bacteria to form dense populations in the lake. Complete overturn occurred in both autumns studied. The stagnant deep water had total phosphorus of 0.3-0.5 mg P/l and ammonia N 1-3 mg/l. Steep gradients of dissolved oxygen, pH, and Eh were found by siphon samplings. Special communities of phytoplankton and bacteria were revealed. A layer of Chlamydomonas sp occurred very close to, and even with, the anoxic zone, and was often associated with peaks of chlorophyll a and primary production. Conspicuous pigment and production peaks were encountered in the upper part of the anoxic zone where purple bacteria occurred. Maximum photosynthesis (184 mg C/cu m/hr) was observed in August in a thin, but very dense layer of Chromatium sp, with a bacteriochlorophyll a value of 484 microgram/l. In the strongly reducing, anoxic deep water, dense populations of green sulfur bacteria developed in both summers; bacteriochlorophyll d reached values up to 4,000 microgram/l, but photosynthetic activity was low, probably due to low light levels. A change to cloudy weather after a long sunny period was associated with a rise in the bacterial plate from 4.1 to 3.4 m depth in August 1982. Purple bacteria (Chromatium sp) were shown to migrate downward during the day and upward at night. (Rochester-IVI)
W86-00930

PHYTOPLANKTON DYNAMICS IN A HYPERTROPHIC BRACKISH-WATER BAY,
Helsinki Univ. (Finland). Dept. of Limnology.
For primary bibliographic entry see Field 5C.
W86-00932

DIATOM FLORA OF THE LLOBREGAT RIVER AND ITS RELATION TO WATER QUALITY,
Barcelona Univ. (Spain). Dept. de Ecologia.
X. Tomas, and S. Sabater.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2348-2352, 1985. 4 Fig, 1 Tab, 5 Ref.

Descriptors: *Diatoms, *Llobregat River, *Spain, *Water quality, *Bioindicators, Species distribution, Species composition, Seasonal variation.

A diatom checklist of the Llobregat River (Spain) is reported, with comments on longitudinal distribution of species, environmental factors, and seasonal effects. Samples were collected at 18 stations along the 156-km length of the main stem, which runs from the Pyreness to the Meditteranean Sea. Except for the last two stations downstream, which are in an area receiving wastewater, diatoms were found everywhere in quantity throughout the year; 116 spp and 34 varieties were identified. The upper four stations covered a montane zone that includes the La Baells reservoir; species richness was moderate, with very few clearly dominant species: the combined relative abundances of Achnanthes minutissima, Cymbella minuta, Diatom hiemale var mesodon, and in winter, Meridion circulare, always exceeded 80%. The next several stations, covering the zone down to the confluence with the Anoia River, exhibited a gradual replacement of species of the first zone by species of Navicula and Gomphonema. Input of salts at the three stations above, at, and just below the confluence with the Gavarresa River enriched these communities; Nitzschia spp and Cyclotella spp, characteristic of the third zone, first appeared here. The last zone, which includes very polluted reaches affected by both industries and towns, extended from the confluence with the Anoia River to the Sea. Populations here were impoverished, with only some pollution-tolerant Nitzschia spp, especially N. frustulum and N. palea, some resistant Navicula spp (N. pelliculosa, N. atomus, and N. permitis), and centric diatoms in abundance. Principal components analysis of the log-transformed percentages of 44 spp suggested relationships between the floristic zones and environmental parameters and indicated seasonal aspects in the diatom flora. (Rochester-IVI)
W86-00950

MICROFAUNA DISTRIBUTION IN SHALLOW MACROPHYTE-COVERED BASINS,
Parma Univ. (Italy). Ist. di Ecologia.

For primary bibliographic entry see Field 5D.
W86-00951

GRAYLING (THYMALLUS THYMALLUS (L.)) IN THE LOWER PART OF THE RAUTALAMPI WATERCOURSE, FINNISH LAKE DISTRICT,
Keski-Suomen Vesipiirin Vesitoimisto, Jyvaeskylae (Finland).
A. Eloranta.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2555-2559, March, 1985. 3 Fig, 2 Tab, 11 Ref.

Descriptors: *Fish populations, *Rautalampi, *Finland, *Graylings, *Lakes, Water temperature, Population dynamics, Spawning, Sport fisheries.

The history, biology and angling catches of grayling in the Rautalampi watercourse, Finland, are described. These fish are derived from the stocking, between 1922 and 1928, of some 182,000 newly-hatched embryos and fingerlings. The main study area was situated in the lower part of the Rautalampi watercourse and comprised 8 rapids and 5 large lakes. Spawning occurred from May 5th to 25th, when the water temperature exceeded 5.0 to 5.5 degrees C. All grayling reached sexual maturity by four years of age. Annuli were laid down on the scales at the start of the growth period in late April or early May. On the average there were 15-19 circuli on the scales of grayling after its first year of life. The oldest fish caught were in their seventh year of life. Males grew faster than females after the onset of sexual maturity. Somatic growth rate declined sharply after the middle of September. The rapids of the Rautalampi watercourse have been sport fishing areas since the beginning of the 1900s. Grayling catches from the lake areas were low, but those from the rapids were high, up to 26.6 kg/ha/a. The grayling is omnivorous and capable of changing flexibly from one food item to another, so that it does not get involved in disastrous food competition or starvation. (Baker-IVI)
W86-00974

CONTRIBUTION OF BACKWATERS TO THE ECOLOGY OF FISH POPULATIONS IN LARGE RIVERS. PRELIMINARY RESULTS ON FISH MIGRATIONS WITHIN A SIDE ARM AND FROM THE SIDE ARM TO THE MAIN CHANNEL OF THE RHONE,
Lyon-1 Univ., Villeurbanne (France). Dept. de Biologie Animale et Ecologie.
Y. Bouvet, E. Pattee, and F. Meggouh.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2576-2580, March, 1985. 7 Fig, 5 Ref.

Descriptors: *Fish migration, *Rhone River, *Backwaters, Rivers, Fish populations, Bullhead, Roach, Tench, Water temperature, Spawning, Seasonal variation.

Three species, the black bullhead, the roach, and the tench, have been seen to dominate the side arm and main channel of the Rhone river. Their occurrence turned out to be rather discontinuous in some stations over the year. Therefore the specimens were individually tagged. The bullhead spend the cold season in the upper reaches, burying into the sediment in winter. They are abundant until March and disappear in spring, probably migrating downstream, returning each year in autumn. Roach migrate up the arm in great numbers at 15 cm (two years of age) in the spring and spawn in the upper half of the arm. After about a month they disappear again, leaving these stations to the fry. Unlike that of the bullhead, the main migration of the roach does not seem to be governed by temperature. Most species of tench in the arm are large, about 40 cm, and old, about 8 to 12 yr. Therefore, their biomass is much more important than their numbers. Some tench are found in summer at the last station upstream, the only fish there at that time. Some quite sedentary specimens were recaptured on the same spot after about 100 days. Others had travelled only small distances and have not migrated downstream in the spring and upstream in autumn. (Baker-IVI)
W86-00975

LIMNOLOGY AND FISHERIES MANAGEMENT IN ZIMBABWE,
Lake Kariba Fisheries Research Inst., Kariba (Zimbabwe).
B. E. Marshall.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2671-2675, March, 1985. 1 Fig, 5 Tab, 16 Ref.

Descriptors: *Zimbabwe, *Limnology, *Fisheries management, Lakes, Reservoirs, Morphoedaphic Index, Fisheries, Fish populations, Model studies, Primary productivity, Conductivity, Phosphorus.

There are no natural lakes and few perennial rivers in Zimbabwe. About 100 large impoundments covering 43,500 ha and Lake Kariba with an area of 536,400 ha are the principal sources of fish at present. Morphometry and conductivity data are available from 33 of them, phosphates from 30, and primary production statistics only from four. While the use of empirical models is often obligatory in a developing country, there is concern about their accuracy, and because of the almost complete lack of fishery data it is difficult to verify them. The Morphoedaphic Index (MEI) is a simple and widely-used empirical model. Since the parameters are easy to estimate the MEI is particularly valuable in areas where detailed limnological studies are lacking. Conductivity is largely controlled by the major dissolved cations (calcium, magnesium, sodium and potassium), but the conductivity of Lake McIlwaine is less closely related and probably influenced by other dissolved material. This supports earlier views that using MEI in culturally enriched lakes is of doubtful validity, thus causing three Zimbabwean lakes (McIlwaine, Upper and Lower Umguza) to be excluded from further study. Recent works suggest that African reservoirs are more productive than natural lakes. Phosphorus is the major limiting nutrient in Zimbabwean lakes, except for some montane ones and those which have been culturally enriched. Most Zimbabwean data are orthophosphate, but this can be changed to total phosphorus for the MEI model. Fish yields were lower than those predicted by the MEI but higher than those from primary production. Too little is presently known about phosphorus in most Zimbabwean lakes, but the model may be useful for future estimations. (Baker-IVI)
W86-00976

FISHING AND HYDROLOGIE IN THE CENTRAL AMAZON (PECHE ET HYDROLOGIE EN AMAZONIE CENTRALE),
Universidade Federal do Rio de Janeiro (Brazil). Dept. de Biologia Marinha.
S. R. P. Annibal.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, Part 4, p 2692-2697, March, 1985. 4 Fig, 12 Ref.

Descriptors: *Fisheries, *Hydrology, *Amazon Basin, *Brazil, *Lago do Rei, Lakes, Commercial fisheries, Flooding, Fish, Population dynamics, Seasonal variation, Limnology, Varzea lakes.

Hydrologic characteristics directly affect fisheries; hydrology also affects the dynamics of exploited flooded regions in the Amazon Basin of Brazil. A study was conducted on a large varzea lake in the central Amazon and two sympatric species of commercial fish. The lake, Lago do Rei, is located on an island in the Amazon River. Data were collected on the hydrology, limnology, biology, and fish of the lake. There is a great variability in the profitability of fishing in the inundation zones of the Amazon. Considering the diversity of the existing fish fauna and the complex ecological interrelations in this region, fish culture should be based on population dynamics, environmental factors and human factors, so that an appropriate seasonal strategy can be proposed for each region. (Moore-IVI)
W86-00977

SUSPENDED SEDIMENT - MICROBIAL INTERACTIONS IN A SHALLOW TURBID IMPOUNDMENT,
National Inst. for Water Research, Pretoria (South Africa).
D. F. Toerien.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2726-2731, March, 1985. 3 Fig, 21 Ref.

Descriptors: *Primary productivity, *Turbidity, *Suspended sediments, *Wuras Dam, *South Africa, Chorophyll, Eutrophication, Bacterioplankton, Mineralization, Dissolved solids.

Wuras Dam (South Africa) is a small, shallow and turbid impoundment which is surrounded by extensive stands aquatic plants. Water samples were taken on a weekly basis from the surface (top 0.5 m) water in the basin. The turbidity of the impoundment increased slowly from about 20 NTU to about 50 NTU over the first 5 months of the study. The assimilation of glucose generally followed Michaelis-Menten kinetics fairly well and the V-max and T1-values of the study probably reflected the dynamics of the bacterioplankton in the impoundment fairly well. The V-max of glucose assimilation was typical of a eutrophic water suggesting that the impoundment was eutrophic on the basis of its chlorophyll a concentration and primary productivity. The suspended solids concentration of the impoundment was high and, due to the ecological importance of bacterial adhesion to solid surfaces, a direct relationship between V-max and turbidity was expected. The fact that a significant relationship was only observed when V-max was lagged with respect to turbidity calls into question the importance of bacterial adhesion in Wuras Dam. The maximum V-max was only observed by the time that the turbidity had already stabilized again after being increased by a flood some 7 weeks earlier. It is possible that flood events result in a large input of allochthonous organic material into impoundments such as Wuras Dam. This organic material is probably mineralized slowly over a period of weeks resulting in an increased flux of dissolved organic material which stimulates the bacterioplankton. (Baker-IVI)
W86-00979

TOTAL NUMBER OF BACTERIA AS A TROPHIC STATE INDEX,
National Inst. for Environmental Studies, Ibaraki (Japan).
M. Aizaki.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2732-2738, March, 1985. 4 Fig, 12 Ref.

Descriptors: *Water quality, *Bacteria, *Trophic level, Lakes, Rivers, Japan, Population dynamics, Nutrients, Phosphorus, Chlorophyll, Dissolved oxygen, Algae, Biomass, Organic matter, Particulate matter.

The possibility of using total number of bacteria as a common trophic state index in stream and lake environments was examined. The total number was determined by the acridine orange direct count (AODC) technique. Twenty-five lakes in Japan were surveyed during summers of 1977 to 1979. Four streams were surveyed in winter, 1981. Bacterial number estimated by the direct count technique had good correlation to environmental factors in lakes and streams. If the regression analysis is conducted in one or a few lakes throughout every season, no significant correlations were obtained. Total number of bacteria estimated by direct count seems also to have characteristics similar to total phosphorus. In this particular study, the lake data used were only from the summer period, when the algal biomass and other variables were probably maximum values, resulting in a high correlation between total number of bacteria and other environmental factors. Particulate and organic matter had high positive correlation coefficients with the direct count when lake and stream data were used simultaneously. This suggests that these variables significantly affect the existence of bacterial populations in flowing water and lake water. Others have confirmed the significance of particulate matter on the existence of bacterial population in aquatic environments. Nutrients seem to have only a loose correlation with the direct count, as distinct from algal biomass. (Baker-IVI)
W86-00980

ELIMINATION OF NUTRIENTS IN THE ROZKOS-RESERVOIR,
Prague Dept. of Water Technology and Environmental Engineering (Czechoslovakia).
For primary bibliographic entry see Field 5B.
W86-01002

SOURCE OF HYDROGEN SULFIDE IN ANOXIC SEDIMENT,
Michigan Univ., Ann Arbor. Dept. of Environmental and Industrial Health.
D. A. Dunnette, D. P. Chynoweth, and K. H. Mancy.
Water Research, Vol. 19, No. 7, p 875-884, 1985. 4 Fig, 8 Tab, 57 Ref. National Institute of Health grant 5T01-EC00030 and EPA grant 5P3-WP-177.

Descriptors: *Hydrogen sulfide, *Lake sediments, *Putrefaction, Sulfur bacteria, Proteolytic bacteria, Bacteria, Anaerobic conditions, Sediments, Eutrophic lakes.

Putrefactive hydrogen sulfide production in the upper 4 cm of sediment in two small freshwater and eutrophic Southeast Michigan, U.S.A., lakes ranged from 0.13 to 1.51 with an average of 0.46 mg S/l/day. Sulfate reductive production of hydrogen sulfide at the same sites ranged from 0.7 to 3.2 with an average of 1.54 mg S/l/day. Putrefactive hydrogen sulfide production represented 5.1-53% (average of 18.3-27.6%) of the total hydrogen sulfide produced at the two lakes over an April-October study period. S-35 labeled substrates were used to estimate hydrogen sulfide production rates. Proteolytic bacteria averaged 22,000 cells/ml sediment whereas sulfate reducers averaged 480 cells/ml sediment. Putrefactive hydrogen sulfide production correlated highly with numbers of proteolytic bacteria (r sq = 0.84) but the correlation between sulfate reduction and sulfate reducing bacteria was low (r sq = 0.13). Interstitial soluble inorganic sulfate, protein and organic carbon were not closely correlated with hydrogen sulfide production rates or bacteria enumeration results. Natural substrate concentration (Sn) used to estimate hydrogen sulfide production were supported by kinetic bioassay results. (Author's abstract)
W86-01063

SOME OBSERVATIONS ON THE OXYGEN CHANGES IN A LAKE COVERED WITH PISTIA STRATIOTES L.,
Ibadan Univ. (Nigeria). Dept. of Preventive and Social Medicine.
For primary bibliographic entry see Field 5C.
W86-01068

PHYTOSOCIOLOGICAL STUDIES ON THE VEGETATION OF IRRIGATION PONDS IN THE SAIJO BASIN, HIROSHIMA PREFECTURE, JAPAN,
Hiroshima Univ. (Japan). Faculty of Science.
M. Shimoda.
Journal of Science, Hiroshima University, Series B, Div. 2, Vol. 19, No. 2, p 237-297, March, 1985. 14 Fig, 37 Tab, 63 Ref.

Descriptors: *Aquatic plants, *Irrigation ponds, *Saijo Basin, *Japan, Vegetation, Swamps, Marshes, Macrophytes, Reeds, Sedges, Rushes, Spatial distribution.

Many ponds are found in the Saijo basin of Hiroshima Prefecture (Japan) because the irrigation of the rice fields has mainly depended upon the reserved water in this area. The aim of the present paper is to classify and record the plant communities developed in and around the irrigation ponds, and to discuss their ecology in relation to several pond conditions. Three major vegetation types can be distinguished: the aquatic vegetation, the emerged shore vegetation, and the reedswamp and marsh vegetation. Vegetation was studied by the Braun-Blanquet approach. From 147 ponds, 421 releves were obtained. The aquatic vegetation comprises submerged communities (Charetea), floating leaf communities (Potametae) and small rush communities (higher units are not yet decided in Japan). In the Potametea two new alliances and one new association are described. The emerged shore vegetation comprises one class (Bidentetea) and two alliances, Lindernion procumbentisu and Eriocaulion hondoensis. Higher units of these alliances are not yet decided in Japan. The reedswamp and marsh vegetation (Phragmitetea) is comprised of communities of reedswamp (Phragmition communis), tall sedges (Galio brevipeduculati-Magnocaricion) and Ischaemum marsh (alliance is not yet decided). Three new associations are described in the Phragmitetea. Distribution of plant communities is influenced by water quality, fluctuations of water level and shape of pond shores. Zonation and succession of plant communities can be seen on the pond shores and in the abandoned ponds. (Author's abstract)
W86-01109

ASSESSMENT OF ECOLOGICAL CHANGES DURING THE RECENT HISTORY OF LAKE ONTARIO BASED ON SILICEOUS ALGAL MICROFOSSILS PRESERVED IN THE SEDIMENTS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
E. F. Stoerner, J. A. Wolin, C. L. Schelske, and D. J. Conley.
Journal of Phycology, Vol. 21, No. 2, p 257-276, June, 1985. 11 Fig, 2 Tab, 80 Ref. EPA grant R810396 and NSF grant OCE-8216588.

Descriptors: *Lake Ontario, *Algae, *Paleolimnology, *History, *Ecology, Diatoms, Chrysophyta, Limiting nutrients, Eutrophication, Phosphorus, Silica, Succession, Species composition.

Quantitative analysis of siliceous algal microfossils (diatoms and chrysophytes) in a radiometrically dated core of Lake Ontario sediments shows striking modifications of the flora produced and preserved, apparently as a result of anthropogenic modification of nutrient loadings to the lake. Qualitatively similar microfossil assemblages were deposited during the period ca. 1700-1815. A single major event is recorded in assemblages deposited ca. 1769. Between this event horizon and ca. 1815 there was an apparent increase in algal production, but minimal change in species composition. A major disturbance occurred at the level of the Ambrosia horizon, ca. 1831-1847. Assemblages deposited between ca. 1855 and 1900 indicate increasing eutrophication. It is inferred that silica limitation became important by about 1860 and that the system reached its greatest effective production ca. 1900. Major modification of the flora occurred in the period ca. 1900-1945, with most local extinctions of major indigenous populations occurring ca. 1920-1945. Assemblages deposited in the period ca. 1945-1975 are composed of some stenothermal populations also present in pre-disturbance assemblages, a large component of benthic and nearshore planktonic species, and a number of apparently planktonic populations rarely recorded from large temperate lakes, particularly species of the genus Nitzschia. The results indicate that the major factor driving species succession in Lake Ontario was phosphorus enrichment and consequent depletion of available silica supplies. The results also show the importance of a species' physical niche in determining its survival under these conditions. (Author's abstract)
W86-01110

PALAEOLIMNOLOGICAL RECORD OF HUMAN DISTURBANCE FROM HARVEY'S LAKE, VERMONT: GEOCHEMISTRY, PIGMENTS AND DIATOMS,
Minnesota Univ., Minneapolis. Limnological Research Center.
D. R. Engstrom, E. B. Swain, and J. C. Kingston.
Freshwater Biology, Vol. 15, No. 3, p 261-288, June, 1985. 11 Fig, 1 Tab, 78 Ref.

Descriptors: *Harvey's Lake, *Vermont, *Geochemistry, *Diatoms, *Lake sediments, Stratigraphy, Sediments, Environmental effects, Land use, Phytoplankton, Primary production, Cyanophytes.

Stratigraphic analyses of inorganic geochemistry, pigments and fossil diatoms in a 0.7 m core of profundal sediments were used to reconstruct the limnological history of Harvey's Lake, Vermont, over the last 1000 years. The lake is moderately productive, deep (44m) and clear, and the phytoplankton today is dominated by the blue-green alga, Oscillatoria rubescens. Sedimentary pigments unique to blue-green algae, oscillaxanthin and myxoxanthophyll, provide a detailed history of changes in the O. rubescens population. Accurate sediment chronology is derived from Pb-210, Cs-137 and C-14 dating and from the stratigraphy of pollen and sawmill wastes. Primary production increased in Harvey's Lake in 1780 following European settlement and again after 1945, as shown by greater accumulation of sedimentary pigments and diatom frustules, and changes in fossil algal assemblages. Blue-green algae first appeared in abundance about 1945, indicating nutrient enrichment from dairy wastes and shoreline development. Increased deposition of elements associated with clastic minerals also suggests greater soil erosion during both of these intervals. Two episodes of increased sedimentary anoxia (1820-1920 and 1945-present) are marked in the sedimentary record by enhanced pigment preservation, changes in authigenic Fe and Mn stratigraphy, and the development of laminated sediments. The earlier episode of oxygen depletion is correlated with the discharge of sawmill wastes into the lake, and the later episode is associated with increased primary production. Based on these data a new model for Fe and Mn sediment stratigraphy was developed for lakes that do not undergo complete hypolimnetic anoxia. Fine-scale resolution of recent diatom and oscillaxanthin stratigraphy provides historical evidence for a long-term negative interaction between diatom and blue-green algal populations in Harvey's Lake. (Author's abstract)
W86-01122

ORGANIZATION OF MACROINVERTEBRATE COMMUNITIES IN THE MAJOR TRIBUTARIES OF THE LATROBE RIVER, VICTORIA, AUSTRALIA,
Museum of Victoria, Abbotsford (Australia). Survey Dept.
R. Marchant, L. Metzeling, A. Graesser, and P. Suter.
Freshwater Biology, Vol. 15, No. 3, p 315-331, June, 1985. 3 Fig, 6 Tab, 42 Ref.

Descriptors: *Macroinvertebrates, *LaTrobe River, *Victoria, *Australia, *Species composition, Species distribution, Ecology, Animal behavior, Food habits, Physicochemical characteristics.

Seventeen sites were each sampled six times over 2 years for macroinvertebrates. A range of physicochemical variables was also measured to determine which factors were related to the distribution of species. Numerical classification of the faunal data indicated that four groups of sites or communities were distinguishable: lowland sites; sandy upland sites; cobble upland sites from the northern catchment; and cobble upland sites from the southern catchment. Multiple discriminant analysis and multiple regression analysis demonstrated that particle size of the sediment, concentration of dissolved ions and altitude were the physicochemical features that were most strongly associated with changes in the faunal distribution. Abundances of shredders and predators did not vary between the site groups while those of scrapers, gatherers and filterers did: scrapers were most abundant at cobble sites while gatherers and filterers were least abundant on sand and increased in abundance downstream. The distribution of the feeding groups showed some similarity with that predicted by the River Continuum Concept, but the fact that the shredders did not decrease in abundance downstream was a notable difference. Abundance of total fauna at a site was inversely related to the amount of benthic organic matter. This feature is contrary to the pattern usually reported from rivers in the northern hemisphere.
W86-01123

QUALITATIVE ANALYSIS OF THE PELAGIC FOODWEBS OF THREE ACID-IMPACTED LAKES IN NOVA SCOTIA, CANADA,
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
P. A. Lane, and A. Blouin.

Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 203-220, 1985. 6 Fig, 7 Tab, 16 Ref. Canadian Wildlife Service, Environment Canada contracts OSC 81-00057, OSC 81-00129, and OSC 81-00210.

Descriptors: *Food chains, *Acid lakes, *Nova Scotia, *Kejimkujik National Park, *Cycling nutrients, *Lakes, Models studies, Loop analysis, Statistical analysis, Ecology, Phytoplankton, Zooplankton, Detritus, Rotifers, Water pollution effects.

Loop analysis is a qualitative network technique which is useful for delineating pelagic foodwebs and for predicting production relationships. Loop models were fitted to data sets for three lakes in Kejimkujik National Park, Nova Scotia. Using qualitative correlation signs, there was 80-89 percent agreement of model predictions an data values. Individual networks were integrated by summarizing linkages between pairs of variables. The resultant core network is a three-layered structure with 5 nutrient, 4 algae, 1 detritus and 10 zooplankton variables. The phytoplankton components utilize different types of nutrient complexes in each lake. Bluegreen algae have a special relationship to ammonia in Beaverskin Lake. Crustacean zooplankton consume phytoplankton directly whereas rotifers are connected to the foodweb via the detrital pool. In contrast to the multivariate statistical results reported previously, loop analysis furnished some robust evidence of the inherent structure in these plankton communities. Qualitative methodology also helps identify casual pathways in the ecological networks. The analysis illustrated which links are oscillating the most and which are expected to remain resilient with increasing perturbation. The models suggest several aspects of these communities that could be verified experimentally. (Author's abstract)
W86-01129

COMPOSITION AND PRODUCTIVITY OF THE BENTHIC MACROINVERTEBRATE COMMUNITY OF A SUBTROPICAL RESERVOIR,
Stephen F. Austin State Univ., Nacogdoches, TX. Dept. of Biology.
J. D. McCullough, and D. W. Jackson.
Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 221-235, 1985. 6 Fig, 6 Tab, 46 Ref.

Descriptors: *Productivity, *Benthos, *Livingston Reservoir, *Texas, *Reservoirs, Primary productivity, Secondary productivity, Phytoplankton, Species diversity, Midges, Oligochaetes.

Physical-chemical conditions, phytoplankton productivity, community structure and productivity of the macroinvertebrate benthic community were determined during 1976-77 in the subtropical Livingston Reservoir (Texas). Physical-chemical results revealed high nitrate and phosphate concentrations with highest values in the riverine segment. Large phytoplankton populations were present during most of the year. Phytoplankton productivity was high, producing an annual mean of 87 mg C/cu m/h (12 hours light/day). High turbidity in the riverine segment limited phytoplankton productivity during winter and spring. Macrobenthos was dominated by chironomids (Chironomus, Procladius, Coelotanypus and Tanypus) and oligochaetes (Limnodrilus). The annual mean benthic population was estimated at 1,626/sq m with a mean dry weight of 0.66 g/sq m. Mean benthic species diversity was 1.80. A lacustrine-riverine community gradient was revealed. Benthic productivity was 6.8 g/sq m/yr (dry weight) with a P:B ratio of 10. A low correlation was observed between benthic and phytoplankton productivity, and between phytoplankton standing crop and benthic macroinvertebrate numbers throughout the reservoir. Algal food supplies had little impact on the benthic community which was composed predominately of species which fed mostly on organic detritus. Stressful conditions caused by low dissolved oxygen concentrations probably inhibited development of the benthic community throughout the reservoir during summer months, while high sedimentation rates limited development in the head waters. (Author's abstract)
W86-01130

PHOTOSYNTHETIC ACTIVITY OF DOMINANT ALGAL SPECIES IN EUTROPHIC SHALLOW LAKE (GROSSER MUGGELSEE, BERLIN) INVESTIGATED BY MICROAUTORADIOGRAPHY,
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographie und Geooekologie.
B. Nixdorf.
Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 237-246, 1985. 8 Fig, 16 Ref.

Descriptors: *Muggelsee, *Berlin, *Germany (Democratic Republic), *Photosynthesis, *Autoradiography, *Eutrophic lakes, Phytoplankton, Productivity, Biomass, Cyanophyta, Diatoms, Isotope studies.

The photosynthetic activity of dominant phytoplankton in a eutrophic shallow lake was investigated by the autoradiographic method in 1979 and 1980. It was shown by light and dark field microscopy that all species of Cyanophyta (Oscillatoria redekei, Oscillatoria agardhii, Aphanizomenon flos-aquae) were characterized by a continuously high uptake of C-14 labeled NaHCO3. Similarly high photosynthetic activity was observed during the occurrence of Cryptomonas sp. and nanoplankton. Contrary to these observations, diatoms showed remarkably high portions of photosynthetically inactive biomass when their development was abundant. The reasons for this discrepancy between high biomass of diatoms and relatively low primary production (measured by the C-14-method and autoradiography) are discussed. (Author's abstract)
W86-01131

COMPOSITIONAL AND STRUCTURAL ANALYSIS OF PHYTOPLANKTON IN LAKE KHURPATAL, (U.P.), INDIA,
Kumaun Univ., Naini Tal (India). Dept. of Zoology.
M. C. Pant, S. Jaiswal, and A. P. Sharma.
Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 269-280, 1985. 6 Fig, 4 Tab, 36 Ref.

Descriptors: *Phytoplankton, *Lake Khurpatal, *India, *Physicochemical properties, Dinoflagellates, Biomass, Species composition, Species diversity.

The phytoplankton community in Lake Khurpatal (Kumaun himalya), India, was analyzed in relation to physico-chemical variables. Phytoplankton biomass ranged from 2.7 to 20.0 g/cu m in the euphotic zone of the lake. Dinoflagellates monopolized the algal community with a mean annual contribution of 94.5% to the total phytoplankton biomass. The community coefficient used to quantify the seasonal changes in algal population reflected the fact that successional episodes were not very significant, the percentage similarity among the consecutive algal samples ranging from 47.8 to 89.9%. The phytoplankton community was characterized by low species richness, low equitability and species diversity. Various ecological characteristics of the community are discussed and the phytoplankton biomass is also compared with that of some tropical and temperate lakes. (Author's abstract)
W86-01133

SOME PHYSICAL AND CHEMICAL PROPERTIES OF WATER FROM AN UNDISTURBED TROPICAL CATCHMENT AREA (GUMA DAM, SIERRA LEONE),
Fourah Bay Coll., Freetown (Sierra Leone). Dept. of Biology.
O. S. M. Mtada.
Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 281-285, 1985. 1 Fig, 1 Tab, 15 Ref.

Descriptors: *Physicochemical characteristics, *Tropical regions, *Guma Dam, *Sierra Leone, Suspended solids, Transparency, Magnesium, Calcium, Silicon dioxide, Carbon dioxide, Hydrogen ion concentration, Phosphorus, Nitrogen, Dissolved oxygen, Chloride, Iron.

Water sampled had a very low content of total suspended solids (< 1 mg/l), but its transparency was high (5-8 Hazen units). The concentration of Mg(2+) and Ca(2+) were below 1 mg/l, but that of SiO2 was 5.3 mg/l. Free CO2 was abundant (15.3 mg/l) and the pH was low (< 6.5). These conditions were accompanied by low concentrations of PO4-P, total iron and NO3-N. The DO content of the water was always below 80%, but chloride concentration (8.4 mg/l) seems relatively high for this type of freshwater. The chloride concentration is, however, much lower than that known for arid areas. It is concluded that the geology and vegetation dominate the chemistry of the water from the Guma Dam catchment area. The influence of man is acknowledged only in as far as he has protected the catchment area. (Author's abstract)
W86-01134

FISH ABUNDANCE RELATED TO ORGANIC MATTER IN THE PLATA RIVER BASIN, SOUTH AMERICA,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina). Dept. de Aguas Continentales.
R. Quiros, and C. Baigun.
Transactions of the American Fisheries Society, Vol. 114, No. 3, p 377-387, May, 1985. 6 Fig, 1 Tab, 49 Ref.

Descriptors: *Fish, *Abundance, *Organic matter, *Plata River Basin, *Argentina, *Uruguay, *Paraguay, *Brazil, *Bolivia, *Parana River, *Uruguay River, *Salto Grande Reservoir, Species distribution, Species composition, Biomass, Phytoplankton, Nutrients, Nitrogen, Total organic carbon, Spatial distribution.

The ichthyofauna of the Plata River Basin (Argentina, Uruguay, Paraguay, Brazil, Bolivia) consists mainly of illiophagous (mud-eating) and detritivorous species. The primary productivity of phytoplankton is generally low. Regressions of ichthyomass and catch per unit effort against total organic nitrogen, total organic carbon, and other variables indicate that much of the spatial variability in fish abundance is explained by the content of the organic matter in the water column. These relationships are demonstrated for the Middle Parana River and for the Salto Grande Reservoir on the Uruguay River. More limited evidence suggests that water column organic matter influences fish distribution elsewhere in the basin as well, and may account for the higher average fish abundance at the mouths of tributary rivers and streams of the Parana and Uruguay rivers. (Author's abstract)
W86-01149

PLASMA OSMOTIC AND ELECTROLYTE CONCENTRATIONS OF LARGEMOUTH BASS FROM SOME ACIDIC FLORIDA LAKES,
Florida Univ., Gainesville. Dept. of Fisheries and Aquaculture.
For primary bibliographic entry see Field 5C.
W86-01154

CHANGES IN THE PLEUSTIC MACROPHYTE FLORA OF 54 SMALL FINNISH LAKES IN 30 YEARS,
Helsinki Univ. (Finland). Dept. of Botany.
H. Toivonen.
Annales Botanici Fennici, Vol. 22, No. 1, p 37-44, 1985. 1 Fig, 3 Tab, 25 Ref.

Descriptors: *Finland, *Lakes, *Macrophytes, *Eutrophication, *Bioindicators, *Pleustophytes, Hydrocharis, Duckweed, Riccia, Ricciocarpos, Spirodela, Stratiotes, Utricularia.

Records made in the late 1940s and the late 1970s in 54 small (0.5-200 ha) lakes in southern Finland (about 61 degrees 30'N) were used to examine changes in the occurrences of ten pleustophytic macrophytes (in order of decreasing frequency: Utricularia vulgaris, Lemna minor, Utricularia minor, Hydrocharis morsus-range, Riccia fluitans, Ceratophyllum demersum, Spirodela polyhiza, Ricciocarpos natans, Lemna trisulca and Stratiotes aloides). The lakes mostly have brown (humic)

water, and represent a wide range of variation as regards the water chemistry, aquatic vegetation and degree of human influence. Most of the species have been favored by increases in the nutrient content of the water, and by factors making the habitats more sheltered. Species which are able to grow well in cool waters, Lemna minor, Riccia and Ricciocarpos, have increased most in abundance. The expansion of Ricciocarpos in the area is explained by eutrophication, and also by its general spread in southern Finland during recent decades. Hypertrophy, caused by excessive eutrophication in some lakes, has led to the marked decline or even to the disappearance of some species (Stratiotes, Lemna trisulca, Utricularia spp.). In heavily eutrophied lakes the submerged vegetation has greatly decreased, probably due to the shading effect of the very high production of phytoplankton. Brief accounts are given of the ecological characteristics of the ten pleustophytes. (Author's abstract)
W86-01156

FACTOR INTERACTION INFLUENCING THE DISTRIBUTION OF THE FRESHWATER 'SHRIMP' GAMMARUS,
Oslo Univ. (Norway). Biologisk Inst.
K. A. Okland, and J. Okland.
Oecologia, Vol. 66, No. 3, p 364-367, June, 1985. 3 Fig, 14 Ref.

Descriptors: *Shrimp, *Crustaceans, *Lakes, *Physicochemical characteristics, *Norway, Altitude, Mountain lakes, Populations, Lime, Calcium, Hydrogen ion concentration, Water temperature, Acid rain, Water pollution effects.

The enormous variation in the environmental factors of south-eastern Norway makes this area particularly suitable for field studies on the relationship between environmental factors and fauna. Lakes are abundant, from 1 to 1,837 m a.s.l., and the geology of the surroundings as well as acid precipitation influence their chemical characteristics. In lowland areas the distribution of Gammarus lacustris is related to how rich in lime the lakes are. Populations found in mountain lakes tolerate much lower levels of calcium and higher H(+) concentrations than populations inhabiting lowland lakes. The lowland populations probably have a higher calcium demand when stressed by high temperature. We predict that factor interaction may be used to explain the distribution pattern of the species also in other parts of Europe. (Author's abstract)
W86-01162

LAKE ANKETJARN, A NON-ACIDIFIED LAKE IN AN ACIDIFIED REGION,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
G. Morling, C. Forsberg, and R. G. Wetzel.
Oikos, Vol. 44, No. 2, p 324-330, April, 1985. 4 Fig, 2 Tab, 15 Ref.

Descriptors: *Lake Anketjarn, *Sweden, *Water chemistry, *Acid lakes, Physicochemical characteristics, Macrophytes, Sulfates, Hydrogen ion concentration, Alkalinity, Water pollution effects, Geochemistry.

Longterm chemical and phytoplankton analyses were made in Lake Anketjarn, Sweden, over a 16-yr period (1967-1982) and compared with those of other softwater lakes in the western portion of Sweden that have experienced severe acidification during the period. Lake Anketjarn exhibited less acidification than the other lakes during the first half of the 1970s and then in recent years partially recovered with reduced H(+) concentrations. The non-acidified characteristics of Lake Anketjarn were likely related to larger deposits of carbonate-containing till in the drainage basin and more recently to the extensive development of the submersed macrophyte Juncus bulbosus that is adapted to utilize benthic sources of CO2. Concentrations of sulfate and H(+) ions have decreased in this lake since about 1977, leading to increases in ratios of acidification-related SO4(2-) over H(+) concentrations. In other nearby acidified lakes these ratios have been constant since alkalinity disappeared in the early 1970s; that constancy indicated that acidification effects are readily reversible once sulfate loading is reduced. (Author's abstract)
W86-01165

SPECIES COMPOSITION AND SEASONAL SUCCESSION OF THE ZOOPLANKTON COMMUNITY OF EUTROPHIC LAHONTAN RESERVOIR, NEVADA,
Nevada Univ. System, Reno. Biology Sciences Center.
J. J. Cooper, and S. Vigg.
Southwestern Naturalist, Vol. 30, No. 2, p 232-252, May, 1985. 8 Fig, 2 Tab, 42 Ref. Office of Water Research and Technology contract 14-34-0001-0271.

Descriptors: *Species composition, *Seasonal variation, *Succession, *Zooplankton, *Lahontan Reservoir, *Nevada, Cladocerans, Copepods, Rotifers, Daphnia, Populations, Eutrophic lakes, Reservoirs, Physicochemical characteristics.

The zooplankton community of eutrophic Lahontan Reservoir, Nevada was studied during a 22-month period of 1980 and 1981. The zooplankton community consisted of seven species of cladocerans, two species of copepods and nine species of rotifers. The dominant zooplankters were the cladocerans Daphnia galeata, D. schodleri, Diaphanosoma leuchtenbergianum, and Bosmina coregoni, the copepods Cyclops vernalis, and Diaptomus sicilis, and the rotifer Keratella. Mean zooplankton density was 37.2/l in 1980 and 64.7/l in 1981. Overall, copepods comprised 50 percent, cladocerans 34 percent, and rotifers 16 percent of the total population. Biotic and abiotic factors are discussed in relation to their potential influence on zooplankton community structure. (Author's abstract)
W86-01168

RECOVERY OF A STREAM INVERTEBRATE COMMUNITY FROM A FLASH FLOOD IN TESUQUE CREEK, NEW MEXICO,
New Mexico Univ., Albuquerque. Dept. of Biology.
M. C. Molles, Jr.
Southwestern Naturalist, Vol. 30, No. 2, p 279-287, May, 1985. 2 Fig, 2 Tab, 27 Ref.

Descriptors: *Benthos, *Streams, *Tesuque Creek, *Santa Fe National Forest, *New Mexico, *Flash floods, *Floods, Ecological effects, Biomass, Species diversity, Streambeds, Flood damage.

In mid-August 1977, a flash flood disrupted the benthic community of one fork of Tesuque Creek, Santa Fe National Forest, New Mexico. One year after the disturbance, the invertebrate communities of flooded and unflooded forks were similar in biomass, numbers, and species diversity. However, even after 2 years some difference in community composition remained. Oligochaetes showed no clear effect from the flood or its aftermath. Diptera recovered rapidly. Ephemeroptera, Plecoptera and Trichoptera recovered at intermediate rates, and Coleoptera recovered most slowly. Recovery proceeded at approximately equal rates upstream and downstream from the undisturbed fork. Comparing preflood to postflood collections yielded approximately the same picture of recovery as comparing postflood collections from undisturbed and disturbed reaches. (Author's abstract)
W86-01170

COLLOIDAL STABILITY OF PARTICLES IN LAKES: MEASUREMENT AND SIGNIFICANCE,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
W. Ali, C. R. O'Melia, and J. K. Edzwald.
Water Science and Technology, Vol. 17, No. 4/5, p 701-712, 1985. 5 Fig, 2 Tab, 18 Ref. NSF grant CEE81-21501.

Descriptors: *Particulate matter, *Particle stability, *Colloids, *Lakes, Aggregation, Fate of pollutants, Colloids, Model studies, Simulation, Hydraulic loading, Dissolved solids, Organic carbon, Solid-solute partitioning.

Under certain chemical conditions, contacts between particles in lakes result in attachment of the colliding particles to form aggregates (the process of coagulation). Model simulations of the effects of particle stability, solid-solute partitioning, and hydraulic loading on the transport and fate of particles and associated pollutants and nutrients were made. Lakes vary widely in hydraulic loading and pollutants vary widely in partition coefficients. Natural particles are rather unstable in lakes, but colloid stability is expected to depend on the hardness and dissolved organic carbon in the water; these also vary widely among lakes. As a result, lacustrine systems are expected to differ appreciably in their ability to assimilate pollutants. A model has been developed to provide a basis for predicting deposition and pollutant concentration in these systems. (Moore-IVI)
W86-01194

PHOSPHORUS, NITROGEN AND CHLOROPHYLL-A CONCENTRATIONS IN A TYPICAL DUTCH POLDER LAKE, TJEUKEMEER, IN RELATION TO ITS WATER REGIME BETWEEN 1968 AND 1982,
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
H. De Haan, and J. R. Moed.
Water Science and Technology, Vol. 17, No. 4/5, p 733-743, 1985. 7 Fig, 2 Tab, 14 Ref.

Descriptors: *Phosphorus, *Nitrogen, *Chlorophyll a, *Tjeukemeer, *Netherlands, Polder lakes, Hydrologic budget, Climate, Limiting nutrients, Chlorophyll a, Algae, Eutrophication.

Tjeukemeer is the largest lake in the province of Friesland, The Netherlands. The lake is connected with other lakes in the region by canals; the interconnected lake system is used to regulate the water table of the low-lying surrounding polders. The mean concentrations of total phosphorus and total nitrogen in the Tjeukemeer during the summer season between 1968 and 1982 were 0.215 and 3.8 mg/l, respectively. These values exceeded water quality standards for The Netherlands. Though the mean summer chlorophyll-a (chl-a) concentration of 116 micro-g/l for 1968-1982 was comparable with that for the basic quality standard, the mean concentrations between 1977 and 1982 were from 1.3 to 2.1 as high. Multiple regression analysis demonstrated that the P and N concentrations in Tjeukemeer in summer and in winter were significantly correlated with the deficit or surplus of water and consequently with the man-made regime. Between 1979 and 1982 the ratios (w/w) of the mean concentrations of total N and total P and those of particulate N and particulate P in summer were less than 16 and 10, respectively, indicating that phytoplankton growth was N rather than P limited. (Moore-IVI)
W86-01196

QUANTIFICATION OF WIND INDUCED RESUSPENSION IN A SHALLOW LAKE,
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
R. H. Aalderink, L. Lijklema, J. Breukelman, W. van Raaphorst, and A. G. Brinkman.
Water Science and Technology, Vol. 17, No. 6/7, p 903-914, 1985. 5 Fig, 2 Tab, 10 Ref, 2 Append.

Descriptors: *Resuspension, *Wind, *Lakes, *Suspended sediments, Mass balance, Sedimentation, Wave action, Shear stress, Mathematical models.

The mass balance of suspended solids in a shallow lake was modelled as the net result of resuspension and settling. Four different formulations for the flux of resuspension were used. Two equations were based on the conception of wave induced resuspension, the other two used the flow field induced shear stress as the driving force for resuspension. Parameter estimations based on experimental time series of wind velocity and SS concentration produced lower least square values with the models based on flow induced resuspension. The model parameter representing settling was in reasonable accordance with the settling velocity obtained from sediment traps. The spread in results can be explained by a lack of homogeneity and horizontal transport. (Author's abstract)

W86-01230

CALCULATION OF TRANSPORT COEFFICIENTS OF PHOSPHATE AND CALCIUM FLUXES ACROSS THE SEDIMENT-WATER INTERFACE, FROM EXPERIMENTS WITH UNDISTURBED SEDIMENT CORES,
Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Chemical Technology.
For primary bibliographic entry see Field 2J.
W86-01233

CONTRIBUTION OF AGRICULTURAL LOADING TO EUTROPHICATION IN FINNISH LAKES,
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 5B.
W86-01247

INDICATIONS OF THE CAPACITY FOR RAPID REVERSIBILITY OF LAKE ACIDIFICATION,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 5B.
W86-01279

DISSOLVED INORGANIC PHOSPHORUS IN STREAMS OF THE INDIAN ARID ZONE,
Central Arid Zone Research Inst., Jodhpur (India).
For primary bibliographic entry see Field 2J.
W86-01292

ANALYSIS OF THE BENTHIC MACROINVERTEBRATE COMMUNITY OF A FLUCTUATING RIVER-RESERVOIR ZONE IN MIDDLE TENNESSEE,
Florida State Dept. of Environmental Regulation, West Palm Beach.
For primary bibliographic entry see Field 6G.
W86-01317

CHEMICAL COMPOSITION OF BOTTOM SEDIMENTS AND PHYTOPLANKTON IN THE MAN-MADE LAKE ZEMBORZYCE NEAR LUBLIN,
Akademia Rolnicza, Lublin (Poland). Inst. of Soil Science and Agricultural Chemistry.
M. Misztal, D. Krupa, and H. Smal.
Acta Hydrobiologia, Vol. 25/26, No. 2, p 123-133, 1983/1984. 3 Fig, 3 Tab, 11 Ref.

Descriptors: *Chemical composition, *Lake Zemborzyce, *Poland, *Bottom sediments, Chemical analysis, Sedimentation, Lakes, Lake sediments.

An analysis was made of the chemical composition of bottom sediments in the man made Lake Zemborzyce near Lublin. Chemical composition of the sediments and its possible relation to the specific composition and percentage content of the systematic groups in the total numbers of phytoplankton was also studied. The content of carbon, nitrogen, and calcium in the reservoir bottom is shown on maps. No relationship appeared to exist between the composition of phytoplankton and the content of the basic available biogens in the sediments. (Baker-IVI)
W86-01319

2I. Water In Plants

COPING WITH DROUGHT BY THE SEA,
King's Coll., London (England). Dept. of Plant Sciences.
P. D. Moore.
Nature, Vol. 315, No. 6019, p 455-456, June, 1985. 1 Fig, 6 Ref.

Descriptors: *Drought, *Plant physiology, *Water stress, Water requirements, Water potentials, Crassulacean acid metabolism.

Plants subjected to periodic or constant water stress display crassulacean acid metabolism (CAM), which is a photosynthetic strategy. A similar phenomenon was recently, surprising, observed in an oceanic member of the Crassulaceae, Umbilicus rupestris (wall pennywort) in response to a drought situation. Some succulent species of plants accumulate acid in their tissues during the night. Leaf acidification is accompanied by the nocturnal uptake of carbon dioxide and a temporary fixation of carbon by the enzyme phosphoenolpyruvate carboxylase into a 4-carbon compound, oxaloacetate. This was subsequently converted to malate. There are clear energetic advantages in the adoption of a flexible system in which it is possible to switch to CAM only during periods when it is of advantage to the survival of the plant, such as in times of water stress. Some species switch to an incomplete form of CAM when experiencing drought. This type of CAM idling has been noted in Umbilicus rupestris when exposed to drought conditions. Evidently the falling water potentials in the plant activate a metabolic switch, but the nature of the operation of this switch is still unknown. Why an oceanic species should posses this unusual capacity for dealing with drought appears to be related to its preferred habitat. Umbilicus rupestris grows in cliff crevices and stone walls, and sometime even grows as an epiphyte in larger plants. In such exposed locations the threat of drought is very real. (Baker-IVI)
W86-01112

STOMATAL RESPONSES AND WATER RELATIONS OF EUCALYPTUS PAUCIFLORA IN SUMMER ALONG AN ELEVATIONAL GRADIENT,
Innsbruck Univ. (Austria). Botanisches Inst.
For primary bibliographic entry see Field 2D.
W86-01163

2J. Erosion and Sedimentation

EFFECT OF KINETIC ENERGY OF EXCESS RAINFALL ON SOIL LOSS FROM NON-VEGETATED PLOTS,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
P. I. A. Kinnell.
Australian Journal of Soil Research, Vol. 21, No. 4, p 445-453, 1983. 5 Fig, 1 Tab, 13 Ref.

Descriptors: *Kinetic energy, *Rain, *Soil loss, Sheet erosion, Soil erosion, Rainfall intensity, Infiltration, Acceptance rate.

In situations where much of the energy required to generate erosion is derived from raindrop impact, soil loss is greatest when runoff occurs. The energy of raindrops is therefore less effectively used in generating soil loss when runoff is absent than when runoff is present. Data obtained from three 0.01 ha runoff and soil-loss plots, established with a bare fallow treatment on a yellow podzolic (Albaqualf) soil and slope gradient of 4.2%, were analyzed in terms of the kinetic energy of raindrops and the efficiency of the use of that energy in generating soil loss. The difference between rainfall intensity and the average infiltration (acceptance) rate of the soil during an event can be used to estimate variations in the efficiency of use of rainfall energy in generating sheet erosion. The product of the rainfall kinetic energy and the excesses in rainfall intensity may prove to be a useful index of the ability of rain to cause sheet erosion, but the product should not be considered as a direct substitute for EI30 in the Universal Soil Loss Equation. (Moore-IVI)
W86-01028

FIELD RAINFALL SIMULATOR STUDIES ON TWO CLAY SOILS OF THE DARLING DOWNS, QUEENSLAND. III; AN EVALUATION OF CURRENT METHODS FOR DERIVING SOIL ERODIBILITIES (K FACTORS),
Queensland Dept. of Primary Industries, Toowoomba (Australia). Wheat Research Inst.
R. J. Loch.
Australian Journal of Soil Research, Vol. 22, No. 4, p 401-412, 1984. 2 Fig, 2 Tab, 32 Ref.

Descriptors: *Soil erosion, *Rainfall simulators, Universal Soil Loss Equation, Runoff, Simulation, Tillage, Slope length, Soil erodibility.

Simulated rain has been widely used to derive soil erodibility (K) values for the Universal Soil Loss Equation (USLE). Because of concern that recent work using smaller plots may not give realistic results, this paper considers the effects of plot length and erosion process on values of K derived from rainfall simulator studies. It also highlights problems in the calculation of K from rainfall simulator data, using the factors of the USLE. Rainulator data on slope length/erosion process interactions were used to calculate soil losses and K for plot lengths of 10.7 and 22.5 m tilled up and down the slope, on two soils, both on 4% slope. K showed up to threefold variation with changes in plot length, because different erosion processes contributed to soil loss. The results also showed major differences between single-event and annual average responses of erosion to slope length, leading to the conclusion that the annual average factors of the USLE cannot be used to analyze single-event rainfall simulator data. Instead, rainfall simulator data must be converted to average annual soil losses, which can then be validly analyzed, using the factors of the USLE, to derive K. The procedures presently used to calculate annual average soil losses from rainfall simulator data do not take into account erosion process/runoff rate interactions, and are therefore unsatisfactory. Single-event soil loss models may provide a means for producing better estimates of annual average soil losses suitable for the derivation of K. (Author's abstract)
W86-01037

FLUID AND SEDIMENT INTERACTION OVER A PLANE BED,
Delaware Univ., Newark. Dept. of Civil Engineering.
N. Kobayashi, and S. N. Seo.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 903-921, June, 1985. 6 Fig, 23 Ref, 1 Append.

Descriptors: *Mathematical models, *Sediment transport, *Sediment-water interactions, Friction, Bed roughness, Model studies, Open channels, Beds.

A mathematical model is developed for the fluid and sediment interaction in an erodible channel. The model is based on the conservation of mass and momentum for the fluid and sediment. The interaction between the fluid and sediment, as well as the interaction of sediment particles moving in the vicinity of the bed is described in the model. An analysis is performed to derive the vertical distributions of the fluid velocity and sediment concentration over a plane bed in a wide open channel. The analysis yields the friction factor due to the combined effects of grain roughness and sediment movement, as well as the rate of sediment transport. The developed model agrees with existing data for plane beds. The predicted rate of transport of coarse sediment agrees with the Meyer-Peter and Muller formula. However, detailed measurements of the fluid velocity and sediment concentration over a plane bed are required for a rigorous verification of the developed model. (Author's abstract)
W86-01045

SEDIMENT TRANSPORT UNDER ICE COVER,
National Water Research Inst., Burlington (Ontario). Environmental Hydraulics Section.
Y. L. Lau, and B. G. Krishnappan.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 934-950, June, 1985. 12 Fig, 3 Tab, 16 Ref, 1 Append.

Descriptors: *Ice cover, *Sediment transport, *Mathematical equations, Free surfaces, Velocity, River beds, Shear stress, Eddy viscosity, Suspended sediments, Bed load, Slope, Friction.

The effects of a floating cover on sediment transport characteristics were investigated through experiments with equal discharge and bed slope for

free-surface and covered flows. The results were used to develop a method for calculating the sediment transport in ice-covered flows. The presence of an ice cover exerts a tremendous influence on the dynamics of flow and sediment transport in a river. Because the wetted perimeter is almost doubled when a cover is formed, the total boundary shear is increased, causing an increase in the flow depth and a decrease in the average velocity. The bed shear stress and the eddy viscosity are both smaller than the corresponding free-surface flow values. The ability of the flow to entrain and suspend sediment is diminished. The resulting decrease in sediment concentration, coupled with the decrease in flow velocity, substantially reduces the suspended sediment transport. The ability of the flow to transport material as bed load is also directly affected by the bed shear stress. Sediment transport rates in some of the experimental runs with a floating cover were much smaller than the free-surface flow values even though the changes in friction velocity were not large. Given the same discharge and bed slope, the presence of a top cover does not have a significant effect on the bed for characteristics. The lower layer in a covered flow can be treated as a free-surface flow for the purpose of calculating bed load transport. (Moore-IVI)
W86-01047

BED MATERIAL MOVEMENT IN HYPER-CONCENTRATED FLOW,
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
Z. Wan.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 987-1002, June, 1985. 10 Fig, 10 Ref, 1 Append.

Descriptors: *Hyperconcentrated flow, *Bed load, Suspended load, Suspended sediments, Sedimentation, Velocity, Clay, Flow intensity, Dunes, Beds.

A series of experiments was made in a closed rectangular conduit with bentonite as fine particles and plastic beads as coarse particles. Compared with that in clear water, in bentonite suspensions coarse particles settle more slowly and start moving at a higher flow intensity. Due to the larger threshold velocity and smaller settling velocity, the bed load is smaller and the suspended load is larger. As a result, the total load, consisting of the bed load and the suspended load, is smaller in the low flow intensity region, but larger in the high flow intensity region. The increase of the suspended load favors the transition from dunes to plane bed. So in clay suspension dunes are lower, flatter, and change to plane bed at lower flow intensity. Correspondingly, the form resistance is smaller in clay suspension. (Author's abstract)
W86-01050

EFFECT OF PIER SPACING ON SCOUR AROUND BRIDGE PIERS,
Nottingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W86-01095

COMPILATION OF ALLUVIAL CHANNEL DATA,
Tetra Tech, Inc., Pasadena, CA.
W. R. Brownlie.
Journal of Hydraulic Engineering, Vol. 111, No. 7, p 1115-1119, July, 1985. 18 Ref. NSF grant CME79-20311.

Descriptors: *Alluvial channels, *Data collections, *Sediment transport, Channels, Flow discharge, Channel morphology, Bed form, Particle size, Water temperature, Computers.

An investigation was undertaken to develop a computer based collection of alluvial channel data. All of the data have been reduced to a standard format in SI units. The following 10 variables are recorded for each observation: discharge, width, depth, slope, median particle size of the bed-material, gradation, specific gravity, concentration, temperature, and bed form. In all, 5,263 records of channel observations from 56 laboratory investigations, and 1,764 records of observations from 24 field investigations have been included. The data collection is available in both report and magnetic tape format from the California Institute of Technology, Pasadena, California. (Baker-IVI)
W86-01097

ESTIMATION OF DISCHARGE AND LOADS FROM THE RIVERS FLOWING INTO LITTORAL SEAS OF CHINA (IN CHINESE),
Academia Sinica, Beijing (China). Inst. of Geography.
T. Cheng, and C. Zhao.
Acta Geographica Sinica, Vol. 39, No. 4, p 418-427, December, 1984. 2 Fig, 6 Tab, 9 Ref.

Descriptors: *China (Peoples Republic), *River flow, *Sediment loads, *River, *Seas, *Coastal waters, *Donghai, *Nanhai, *Pacific Ocean, *Bohai, Rivers, Sediment transport, Seasonal variation, Annual distribution, Precipitation.

Based on the data collected from 164 hydrological stations situated at downstream river regions (3022 station years up to 1979) the annual averages of runoff and loads flowing into the seas from the rivers in littoral areas of China were estimated; they are approximately 1800 cu km and 2000 million tons respectively and account for 4.6% and 11.5% of the total world volume, while the content of soluble substances in the runoff is about the same as that of the world. Under annual average, the Donghai receives most of the discharge (approximately 64.5% of the total), Nanhai comes next, and the Pacific receives the least. The distribution of runoff that empties into the seas both in dry and wet years is comparable to that of the annual average; the most apparent variation of dry and wet years is observed in Bohai, while variation in Donghai and the Pacific are not as apparent. The Bohai also show the most apparent variation in sediment transport. During 1970-1979, both runoff and loads discharged into Bohai decreased and increased in Nanhai. In addition to the impact of periodic variation of precipitation in drainage areas, the increase and decrease of runoff is also affected by human activities; an example is when the precipitation of drainage areas varies little but, due to human activities, the runoff decreases. Since the last decade, the amount of runoff discharged into Donghai decreased slightly, but the loads increased accordingly; an increase of 5.4% has been observed. Yearly and seasonal variations of runoff and loads discharged into the seas are controlled by the major rivers that emptied into the sea areas. The variation of runoff and loads of most rivers within the sea area are consistent with each other. (Author's abstract)
W86-01167

EROSIONAL PROCESS OF COHESIVE SEDIMENTS,
Kyushu Univ., Fukuoka (Japan). Dept. of Hydraulic Civil Engineering.
T. Kusuda, T. Umita, K. Koga, T. Futawatari, and Y. Awaya.
Water Science and Technology, Vol. 17, No. 6/7, p 891-901, 1985. 14 Fig, 6 Ref.

Descriptors: *Sediment erosion, *Cohesive sediments, Chikugo Estuary, Japan, Shear stress, Estuaries, Velocity, Simulation, Mathematical models.

Tests on erosion of the cohesive sediments in the Chikugo estuary in Japan were conducted. The results indicate that the decrease in the rate of erosion at constant shear stresses is caused rapidly 20 to 30 minutes after the start of tests and that the decrease in caused by the increase in the solid fraction and the yield value of the sediment remaining uneroded due to shear stress. In order to simulate the erosion process of sediments, a model in which the increase in the yield value of sediment is assumed to be proportional to the integration value of the absolute value of the sediment velocity gradient with respect to time was developed. The simulation based on this model is shown to be available to estimate the amount of sediments eroded in the erosional process of cohesive sediments. (Author's abstract)
W86-01229

QUANTIFICATION OF WIND INDUCED RE-SUSPENSION IN A SHALLOW LAKE,
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
For primary bibliographic entry see Field 2H.
W86-01230

BEHAVIOUR OF SUSPENDED SEDIMENTS AND MUDS IN AN ESTUARY,
Iwate Univ., Morioka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W86-01231

CALCULATION OF TRANSPORT COEFFICIENTS OF PHOSPHATE AND CALCIUM FLUXES ACROSS THE SEDIMENT-WATER INTERFACE, FROM EXPERIMENTS WITH UNDISTURBED SEDIMENT CORES,
Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Chemical Technology.
W. van Raaphorst, and A. G. Brinkman.
Water Science and Technology, Vol. 17, No. 6/7, p 941-951, 1985. 4 Fig, 4 Tab, 15 Ref.

Descriptors: *Sediment-water interfaces, *Phosphates, *Calcium, *Solute transport, Lake sediments, Interstitial water, Benthic environment, Desorption, Chemical kinetics.

Transport of dissolved materials across the sediment-water interface is an important factor, affecting the chemical characteristics of lakes. For calculating benthic fluxes, concentration gradients and transport coefficients have to be known. Fluxes of phosphate and calcium across the sediment-water interface of six undisturbed cores from a shallow lake were investigated in the laboratory. Study of the accuracy of porewater extraction and the influence of this sampling upon the experiments indicates that sampling time should at least be one day. Continuous and batch experiments resulted in a rapid release of phosphorus and calcium from the sediment. The influence of induced seepage could not be shown. On a theoretical base, the benthic fluxes are fed by desorption at or just below the interface, rather than by diffusion from deeper layers. Interstitial water data could not directly be used for calculating the driving forces of these fluxes. Instead, end-concentrations in the overlaying water of the batch experiments are used, which resulted in transport coefficients which are in good agreement with theoretical as well as field data. A good interpretation of measured fluxes is only possible when a good estimation can be made of the kinetics of the chemical reactions in the sediment; core experiments should be accompanied by such analysis. Values for the equilibrium concentration are needed, which can best be obtained from batch experiments. Core experiments can be useful in studying the transport of solutes across the sediment-water interface. (Moore-IVI)
W86-01233

DISSOLVED INORGANIC PHOSPHORUS IN STREAMS OF THE INDIAN ARID ZONE,
Central Arid Zone Research Inst., Jodhpur (India).
J. S. Choudhari.
Journal of Hydrology, Vol. 78, No. 1/2, p 49-59, May, 1985. 6 Fig, 3 Tab, 19 Ref.

Descriptors: *Inorganic phosphorus, *Phosphorus, *Nutrients, *Luni River basin, *India, *Streams, *Deserts, Arid climates, Intermittent streams, Suspended solids, Lithology, Slopes.

Streams of arid regions, which flow only in direct response to torrential rainfall have not been studied for P concentration. Total dissolved inorganic phosphorus concentrations in stream waters of the Luni River basin in the northwest-Indian desert were determined during 1980 and 1981; previous reports indicate that dissolved inorganic P constitutes a major portion of total P in those stream waters. The P concentration varied between 0.03 to 4.56 micro-g/ml PO4(-3) in various streams. The Upper Luni, Mitri, Khari and Sagi streams showed higher concentrations of P during both years of study compared to those of the Guhiya, Bandi, Jojri and Khari Bandi streams. This could possibly

be due to variation in soil cover and slope gradient. Former streams draining hilly terrain with shallow gravelly weathering surfaces and greater slopes, could have increased the effective soil mass that interacted with runoff and generated higher concentrations of P. Suspended solids, produced by low-energy runoff from dry, loose soil surfaces formed during dry periods, and flow characteristics govern the concentration of total dissolved P in streams of the Indian arid region. Flow characteristics, lithology, transmission losses and soils which control the production and transportation of suspended solids influence the P concentration of stream waters in this arid region. (Collier-IVI)
W86-01292

GRADIENT CONTROLLED CAVES, TRAPPER-MEDICINE LODGE AREA, BIGHORN BASIN, WYOMING,
Wyoming Univ., Laramie. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2F.
W86-01305

2K. Chemical Processes

EFFECTS OF WATERLOGGING AND SUBSEQUENT DRAINAGE OF A PASTURE SOIL ON PHOSPHATE SORPTION, EXTRACTABLE PHOSPHATE AND OXALATE-EXTRACTABLE IRON,
New South Wales Dept. of Agriculture, Rydalmere (Australia). Biological and Chemical Research Inst.
J. Bradley, I. Vimpany, and P. J. Nicholls.
Australian Journal of Soil Research, Vol. 22, No. 4, p 455-461, 1984. 3 Fig, 26 Ref.

Descriptors: *Waterlogged soils, *Drainage effects, *Phosphates, *Iron, Pastures, Sorption, Soil chemistry, Seasonal variation, New South Wales.

Undisturbed cores of a pasture soil from the central tablelands of New South Wales were waterlogged for periods varying from 4 to 42 days and then drained to simulate seasonal waterlogging. Phosphate sorption, Bray 1 extractable phosphate and oxalate-extractable iron levels were measured before watering, at the end of waterlogging and up to 90 days after draining. Increasing the duration of waterlogging increased the logarithms of phosphate sorption and Bray 1 extractable phosphate linearly, but the response equation of log oxalate iron was significantly quadratic. When drained, all three levels fell, but the positive sorption response to waterlogging remained 90 days after draining. These results are consistent with those from previous studies that found phosphate solubility to be associated with the reduction of iron during waterlogging and its subsequent oxidation on drying. The agronomic implication of the findings for superphosphate topdressing of seasonally waterlogged soils is discussed. (Author's abstract)
W86-01038

LAKE ANKETJARN, A NON-ACIDIFIED LAKE IN AN ACIDIFIED REGION,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 2H.
W86-01165

APPLICATION OF INFORMATION ABOUT CONDUCTIVITY IN THE COMPUTING OF ION CONCENTRATIONS, ILLUSTRATED BY CERTAIN SURFACE WATERS SITUATED IN LOWER SAXONY,
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Stadtbauwesen.
For primary bibliographic entry see Field 5A.
W86-01224

CALCULATION OF TRANSPORT COEFFICIENTS OF PHOSPHATE AND CALCIUM FLUXES ACROSS THE SEDIMENT-WATER INTERFACE, FROM EXPERIMENTS WITH UNDISTURBED SEDIMENT CORES,
Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Chemical Technology.
For primary bibliographic entry see Field 2J.
W86-01233

MODEL STUDY OF SALT-WATER INTRUSION TO A RIVER USING THE SHARP INTERFACE APPROXIMATION,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 2F.
W86-01308

2L. Estuaries

COMPARISON OF PLANKTONIC AND PERIPHYTIC MICROALGAL PARAMETERS AS INDICATORS OF EUTROPHICATION IN A BALTIC ARCHIPELAGO: ANNUAL SUCCESSION OF COMMUNITY PARAMETERS,
Tvarminne Zoological Station (Finland).
For primary bibliographic entry see Field 7B.
W86-00931

WAVE FORCES ON VERTICAL WALLS,
New South Wales Univ., Kensington (Australia). School of Mathematics.
For primary bibliographic entry see Field 8B.
W86-01098

DOMINANT SHEAR STRESSES IN ARRESTED SALINE WEDGES,
Thessaloniki Univ., Salonika (Greece). Dept. of Civil Engineering.
V. Dermissis, and E. Partheniades.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 111, No. 4, p 733-752, July, 1985. 10 Fig, 17 Ref. NSF grant ENG. 76-11537-A01.

Descriptors: *Saline wedge, *Shear stress, Mathematical models, Velocity, Saline-freshwater interfaces, Friction, Bed resistance, Density.

The shear stresses in saline wedges have been investigated in a 20 m long variable slope flume by the following approaches: (1) Direct measurements of velocities and Reynolds stresses through hot film anemometers; (2) integration of the equations of motion; (3) Schijf-Schoenfeld's one-dimensional model; (4) integration of the equations of motion assuming zero bed stress. It was found that the interfacial and bed friction coefficients, fi and fo, respectively, can best be correlated with the number ReFr sq, in which Re is the Reynolds number, and Fr is the nondensimetric Froude number and with the relative density delta p/p taken as an independent parameter. The results are given as a family of curves with each curve corresponding to a specific delta p/p. The scattering of data is small and the agreement with results of earlier studies is good. Values of fi determined by the first two approaches agree closely, as do values obtained by the third and fourth approach. However the latter are substantially higher than the first. This is indicative of a strong effect of the bed resistance on the interfacial friction. (Author's abstract)
W86-01099

PREDICTED EXTREME HIGH TIDES FOR CALIFORNIA: 1983-2000,
Scripps Institution of Oceanography, La Jolla, CA.
B. D. Zetler, and R. E. Flick.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 111, No. 4, p 758-765, July, 1985. 1 Fig, 4 Tab, 6 Ref. Office of Naval Research contract N00014-83-C-0182.

Descriptors: *California, *Tides, *Prediction, Forecasting, Coastal areas, Design criteria, Spring tides, Perigean tides, Tropic tides, Perihelion tides.

The combination of high tides and storm-induced waves were devastating to the coast of California during the winter of 1982-1983. Studies of sea level trends depend primarily on accumulated tide gage data over many years. Spring tides are large semi-daily tides that occur twice a month near full and new moons when the lunar and solar attractions are superimposed. Perigean tides are large semidaily tides that occur monthly when the moon is closest to the earth. There are also tropic tides and perihelion tides. Obviously, tides will be particularly high when spring tides coincide with perigean tides, tropic tides, perihelion and so forth. Tables are presented which furnish monthly and annual extreme high tide predictions for 1983 through 2000. The predictions in these tables will provide a measure of reassurance to those concerned with California's coastal zone and should be useful in the design of protective structures and other coastal engineering projects. Tremendous high tides are not predicted for the remainder of this century. Nevertheless, the highest tides in the period 1986-1990 will be slightly higher than those of the winter 1982-1983 due to enhancement of the diurnal lunar constituents in the 1986-1990 period of the moon's node cycle. (Baker-IVI)
W86-01100

ARSENIC, BARIUM, GERMANIUM, TIN, DIMETHYLSULFIDE AND NUTRIENT BIOGEOCHEMISTRY IN CHARLOTTE HARBOR, FLORIDA, A PHOSPHORUS-ENRICHED ESTUARY,
Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W86-01113

SEA-SURFACE MICROLAYER METALS ENRICHMENTS IN AN URBAN AND RURAL BAY,
Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
For primary bibliographic entry see Field 5B.
W86-01114

FLUXES AND RESIDENCE TIMES OF HYDROCARBONS IN THE COASTAL MEDITERRANEAN: HOW IMPORTANT ARE THE BIOTA,
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5B.
W86-01115

UPWELLING AND RIVER RUNOFF AS SOURCES OF DISSOLVED NITROUS OXIDE TO THE ALSEA ESTUARY, OREGON,
Oregon State Univ., Corvallis. Coll. of Oceanography.
M. A. de Angelis, and L. I. Gordon.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 4, p 375-386, April, 1985. 4 Fig, 4 Tab, 34 Ref. ONR contract N00014-79C-0004.

Descriptors: *Nitrous oxide, *Upwelling, *Runoff, *Alsea Estuary, *Oregon, Nitrates, Nitrites, Nitrification, Floods, Estuarine environment, Dissolved gases.

Surface waters of Alsea Bay, an unpolluted estuary on the Oregon coast, were analyzed for nitrous oxide, nitrate and nitrite on a weekly or biweekly basis during the summer of 1979. The estuary was found to be a variable source of N2O to the atmosphere. Large and rapid increases in the concentrations of N2O, NO3(-), and NO2(-) occurred at the beginning of the sampling period and are attributed to the influx of nutrient-rich upwelling water into the estuary with the tide. The subsequent decline in concentrations of nitrate, nitrite and nitrous oxide over the remainder of the summer is attributed to a decrease in upwelling intensity, a decline in nitrification rates and to assimilatory nitrate reduction. Measurements of nitrous oxide at six stations along the Alsea River were also made in September and October before and after the onset of the rainy season. Samples taken after flood conditions were established were systematically 50% higher than pre-flood samples. The data suggest that soil runoff results in elevated concentrations of N2O in rivers. (Author's abstract)
W86-01117

ARSENIC INCORPORATION IN A SALT MARSH ECOSYSTEM,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 5B.
W86-01118

EFFECTS OF WIND, PHYTOPLANKTON AND DENSITY DISCONTINUITIES UPON AMMONIA DISTRIBUTIONS IN LIVERPOOL BAY,
University Coll. of North Wales, Menai Bridge. Marine Science Labs.
P. Foster, J. Beardall, D. Voltolina, and G. Savidge.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 4, p 463-475, April, 1985. 7 Fig, 1 Tab, 10 Ref.

Descriptors: *Fate of pollutants, *Ammonia, *Liverpool Bay, *Wind, *Phytoplankton, *Destratification, Spatial distribution, Temporal distribution, Nitrogen, Silicates, Nitrates, Seasonal variation.

Spatial and temporal changes in distributions of ammonia and of physical and biological characteristics observed in Liverpool Bay during a seasonal production cycle are presented. Ammonia concentrations did not conform to the well defined seasonal trend in levels of silicate and nitrate; this led to a temporal variability in the relative contributions of nitrite and ammonia to the total inorganic nitrogen pool. The gross changes in ammonia concentrations and distributions in Liverpool Bay may be related to the effects of three predominant factors, namely the effect of wind upon the surface residual circulation during winter, the development of the phytoplankton bloom during spring and the presence or absence of a marked discontinuity. (Author's abstract)
W86-01120

VARIATIONS IN THE NATURAL ABUNDANCE OF 15N IN ESTUARINE SUSPENDED PARTICULATE MATTER: A SPECIFIC INDICATOR OF BIOLOGICAL PROCESSING,
Institute for Marine Environmental Research, Plymouth (England).
N. J. P. Owens.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 4, p 505-510, April, 1985. 2 Fig, 21 Ref.

Descriptors: *Nitrogen radioisotopes, *Estuarine environment, *Suspended particles, *Particulate matter, *Chemical reactions, Isotope studies, Cycling nutrients, Catabolism, Anabolism, Particle size, Manganese, Hydrocarbons.

The composition of particle populations suspended in estuaries is controlled not only by the intermixing of source materials of marine and riverine origins but also by significant in situ hydrodynamic selectivity, and chemical and biological modification. The measurement of the stable isotope ratios of nitrogen (N-14:N-15) has made a significant contribution to knowledge of the sources and sinks of particulate material in a variety of environments. The N-14:N-15 ratio of suspended particulate material collected from the Tamar river estuary, south-west England, was determined to obtain information on the natural abundance of N-15 in estuaries. Three populations of particles, distinguishable by their N-15 content, were observed. Results indicate that populations of estuarine particles are generated by biological transformation in situ and that the N-15 content of estuarine particles does not merely reflect hydrodynamic mixing of the freshwater and seawater source particulate material. Biologically mediated catabolism and anabolism of organic nitrogen occurs in distinct regions and gives rise to distinct populations of particles. These observations have implications concerning the biogeochemical processes which occur in an estuary such as removal of manganese and distribution of high molecular weight polyaromatic hydrocarbons. (Collier-IVI)
W86-01121

SHORT-TERM AND LONG-TERM INFLUENCES ON THE IMMIGRATION OF POSTLARVAL BANANA PRAWNS PENAEUS MERGUIENSIS, INTO A MANGROVE ESTUARY OF THE GULF OF CARPENTARIA, AUSTRALIA,
Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs.
D. J. Staples, and D. J. Vance.
Marine Ecology - Progress Series, Vol. 23, No. 1, p 15-29, 1985. 11 Fig, 7 Tab, 40 Ref.

Descriptors: *Shrimp, *Estuarine environment, *Migration, *Fish migration, *Gulf of Carpentaria, *Australia, *Norman River estuary, Growth stages, Larval growth stage, Animal behavior, Physicochemical characteristics, Water temperature, Salinity, Nutrients, Seasonal variation.

Postlarval Penaeus merguiensis de Man were sampled regularly at the mouth of the Norman River estuary in the south-eastern Gulf of Carpentaria, Australia, from 1975 to 1979. A grid of stations up to 10 km offshore from the estuary mouth was also occupied over a 24 h period during November 1978. In these offshore stations, postlarvae migrated vertically in the water column in response to changes in tidal height, rising to near the surface just below low tide. Postlarvae entered the estuary throughout the flood tide with a peak in abundance occurring at the time of maximum current, regardless of time of day or night. During the monsoonal wet season (Dec-Mar), when estuary salinities were lower, postlarvae occurred deeper in the water column. Over the 4 yr of sampling, immigration on a day-to-day basis was extremely variable but a consistent spring-neap tidal cycle could be demonstrated. More postlarvae immigrated during the spring-tide period than during the neaps, although the pattern was complicated by a larger peak associated with every second spring tide (27.32 d). Although difficult to separate from tidal phase changes, lunar changes per se appeared to be less important than the relation between tidal phase changes and timing of moonset and moonrise. Immigration was restricted to the warmer months between October and April each year, with a large pulse of recruits occurring usually in spring (Oct-Nov) and a less consistent pulse occurring in autumn (Mar-May). Inter-annual variations were also large and it was suggested that these year-to-year differences were related to the amount of rainfall recorded during the previous wet season (9 mo earlier) and the associated changes in salinity, temperature, nutrients and abundances of adult prawns. Over larger time scales, both size and developmental stage (number rostral spines) were directly related to postlarval abundance. Thus, postlarvae tended to be larger and more well developed during spring and autumn of each year, and were also larger during years of high immigration rates. Increased growth as well as survival in years following good rainfall and enrichment is suggested. (Author's abstract)
W86-01125

NUTRIENT REGENERATION AND OXYGEN CONSUMPTION BY SEDIMENTS ALONG AN ESTUARINE SALINITY GRADIENT,
Maryland Univ., Solomons. Chesapeake Biological Lab.
W. R. Boynton, and W. M. Kemp.
Marine Ecology - Progress Series, Vol. 23, No. 1, p 45-55, 1985. 7 Fig, 1 Tab, 65 Ref.

Descriptors: *Cycling nutrients, *Oxygen demand, *Sediments, *Estuarine environment, *Chesapeake Bay, *Sediment-water interfaces, Spatial distribution, Environmental gradient, Salinity gradient, Phosphorus, Nitrates, Nitrogen, Ammonium.

Nutrient fluxes and oxygen consumption (SOD) across the sediment-water interface were measured in situ along with vertical profiles of dissolved and particulate-phase nutrients in sediments and overlying water at 8 locations along the salinity gradient of Chesapeake Bay during spring and summer. Strong spatial and temporal patterns were evident. Highest rates of sediment NH4(+) regeneration and SOD occurred in summer at mid-salinity (12 to 17‰) stations. Sediment fluxes of dissolved inorganic phosphorus (DIP) were always low, possibly due to relatively oxidized conditions in surficial sediments. Nitrate (NO3(-)) fluxes generally were directed into the sediments in spring and from the sediments during summer, and in both seasons fluxes were proportional to NO3(-) concentrations in overlying waters. Seasonal shifts in sediment O:N flux ratios suggest that denitrification may have been important in spring but not summer. Significant relations were inferred between C:N:P composition of suspended materials and surficial sediments and the magnitude and direction of sediment-water fluxes. Although accretion of particulate nitrogen in sediments was less than 6% of NH4(+) regeneration in the lower bay, it was similar to rates of NH4(+) flux in the low salinity region, suggesting that burial represents a significant sink for N in some estuarine zones. SOD constituted an important term in watercolumn O2 budgets at all stations (16-50% of total respiration), and sediment regeneration of NH4(+) was capable of supplying 13 to 40% of calculated phytoplankton N requirement, being more important during the summer period of higher productivity. (Author's abstract)
W86-01126

HYDROLOGY AND CHANGES IN THE NUTRIENTS AND PHYTOPLANKTON LEVELS IN GOAT ISLAND BAY, NORTHERN NEW ZEALAND,
Auckland Univ., Leigh (New Zealand). Marine Research Lab.
N. J. Taylor, and F. J. Taylor.
Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 173-186, 1985. 12 Fig, 2 Tab, 15 Ref.

Descriptors: *Nutrients, *Phytoplankton, *Estuarine environment, *Goat Island Bay, *New Zealand, *Bays, Solar radiation, Nitrates, Land use, Environmental effects, Ammonia.

Quantitative phytoplankton samples were taken fortnightly from four stations in Goat Island Bay, northern New Zealand, and from one station in the inflowing creek, over the period June 1981 to August 1982. The nutrient levels at each station were also measured. The phytoplankton was similar in quantity and composition to that found in an earlier survey in 1966-69. No correlations were found between the phytoplankton densities and the nutrient levels. Significant correlations of the phytoplankton were obtained with radiation levels. This indicates that the phytoplankton populations are limited by light intensity and not by nutrient availability. The only significant change was a doubling of the dissolved nitrate levels in the sea, which appeared to be related to increased nitrate levels in the freshwater creek. It is suggested that the increase is due to an increase in the farming and recreational use of the catchment area. Nutrient levels in the creek were, except for ammonia, higher than in the sea. Some evidence is presented that the increase in the nitrate levels in the sea was associated with increased nitrate levels in the creek. (Collier-IVI)
W86-01127

EXPERIMENTAL STUDIES ON THE SUSCEPTIBILITY OF FRESHWATER PHYTOPLANKTON TO VARIATION OF SALINITY IN THE FJORD OF SAGUENAY (ST. LAWRENCE ESTUARY), CANADA (ETUDES EXPERIMENTALLES SUR LA SENSIBILITE DU PHYTOPLANCTON D'EAU DOUCE AUX VARIATIONS DE SALINITE DANS LE FJORD DU SAGUENAY (ESTUAIRE DU ST-LAURENT), CANADA),
Quebec Univ., Chicoutimi. Dept. des Sciences Fondamentales.
S. Cloutier, and R. Cote.
Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 187-201, 1985. 12 Fig, 33 Ref.

Descriptors: *Phytoplankton, *Salinity, *Fjord of Saguenay, *St. Lawrence Estuary, *Quebec, Diatoms, Stress, Seasonal variation, Environmental gradients.

The Saguenay Fjord is characterized by very high run-offs. The annual flow varies between 1200 and 4200 cu m/s. During the summer the surface salinity shows a sharp horizontal gradient (from 1 0/00 to 20 0/00). The surface phytoplankton, mainly

freshwater and even some euryhaline species, is submitted to salinity stress. Continuous culture experiments were conducted to study the susceptibility of this freshwater phytoplankton under different salinity conditions. Some pennate diatoms (dominant group) are found as relatively tolerant to salinity. Microflagellates have been found to be resistant to salinity up to 26 0/00. Chlorophyll concentrations and rates of primary production of those organisms are as high as those of the control. (Author's abstract)
W86-01128

TWO-DIMENSIONAL CALCULATION OF TIDE BY EXPLICIT WEIGHTED RESIDUAL METHOD - I SHIBUSHI BAY,
Kagoshima Univ. (Japan). Faculty of Fisheries.
H. Kikukawa, and I. Seo.
Memoirs of the Faculty of Fisheries, Kagoshima University, Vol. 33, No. 1, p 13-21, December, 1984. 12 Fig, 9 Ref.

Descriptors: *Tides, *Shibushi Bay, *Japan, *Predictions, *Biro Island, Tidal hydraulics, Winds, Water currents, Bays.

A two-dimensional explicit weighted residual method is applied to estimate the tidal residual flow of Shibushi Bay. Only the M sub 2 tide is taken into account. The effects of the ocean current, the wind stress, the river current, the bottom stress etc. were not considered. The water mass is found to be well conserved after the 7 periods of calculations. There appear in the tidal residual flow a clockwise circulation around Biro Island and an anti-clockwise flow at the south of Biro Island. In the time averaged equation of momentum, the advective term and the gravity term are balanced at the inner part of the bay; at the outer part of the bay, the advective term, the gravity term and the Coriolis term are balanced. The viscous term is only important around Biro Island. The phase delay of the water surface elevation is found to be negligible all over the bay. (Author's abstract)
W86-01144

SEASONAL CHANGES IN THE GENERIC COMPOSITION OF HETEROTROPHIC BACTERIA IN SEAWATER OF KAGOSHIMA BAY (IN JAPANESE),
Kagoshima Univ. (Japan). Faculty of Fisheries.
For primary bibliographic entry see Field 5B.
W86-01148

USE OF THE RB/K RATIO TO EVALUATE POTASSIUM NUTRITION OF PEATLANDS,
Minnesota Univ., St. Paul. Dept. of Soil Science.
C. G. Buttleman, and D. F. Grigal.
Oikos, Vol. 44, No. 2, p 253-256, April, 1985. 1 Fig, 2 Tab, 14 Ref. NSF grant DEB 7922142, and Minnesota Agricultural Experiment Station project 25-54.

Descriptors: *Rubidium, *Potassium, *Peatlands, *Peatbogs, *Minnesota, Nutrients, Vegetation, Plant physiology, Bogs, Mosses, Wetlands.

The Rb/K ratio was determined in two classes of forested peatlands, raised and perched bogs, in northern Minnesota. These two classes of bogs are deficient in K, but differ somewhat in degree of deficiency and in source of K. Differentials were sought in the Rb/K ratio between the two classes of bogs. The ratio was significantly lower in the living vascular vegetation on the raised bogs, but significantly higher in the deep peat in those bogs. There was no difference in the ratio in the living moss and shallow peat between bogs in the two classes. The ratio was apparently affected by biological selectivity in K uptake by plants under low-K conditions. These results raise questions concerning use of this ratio in ecosytem studies. (Collier-IVI)
W86-01164

ENHANCEMENT OF MARINE PRIMARY PRODUCTION BY NITROGEN-ENRICHED ACID RAIN,
North Carolina Univ. at Morehead City. Inst. of Marine Sciences.
For primary bibliographic entry see Field 5C.
W86-01172

ROLE OF PHYTOPLANKTON IN THE DISSOLVED OXYGEN BUDGET OF A STRATIFIED ESTUARY,
Southern Water Authority, Otterbourne (England). Resources Planning Lab.
P. G. Soulsby, M. Mollowney, G. Marsh, and D. Lowthion.
Water Science and Technology, Vol. 17, No. 4/5, p 745-756, 1985. 9 Fig, 20 Ref.

Descriptors: *Test Estuary, *England, *Mesodinium, *Eutrophication, *Dissolved oxygen, Phytoplankton, Photosynthesis, Vertical migration, Mathematical models, Stratification, Estuarine environment, Chlorophyll a.

The Test Estuary situated at the head of Southamption Water, southern England was identified as likely to be subject to a series of developments which would require careful consideration of their impact on its water quality. Dissolved oxygen was identified as the most important parameter for consideration since the estuary carries a substantial run of salmon each summer. In the Test Estuary, the lowest dissolved oxygen levels followed a mid summer phytoplankton bloom, dominated by the ciliate Mesodinium rubrum. A numerical model was developed to calculate the water circulation, vertical mixing, dissolved oxygen and chlorophyll a. To obtain agreement between observed and predicted dissolved oxygen and chlorophyll a distributions, it was necessary to simulate a unique characteristic, the diurnal vertical migration of Mesodinium. Mesodinium is extremely motile; during the day the main concentration of Mesodinium is found between 1 and 3 m, but a substantial downward movement occurs just before dusk and within 30 minutes the bulk of the population is contained in the botton third of the depth. This position is maintained throughout the hours of darkness, but prior to dawn, a substantial movement towards the surface occurs. During the bloom period supersaturated oxygen levels are maintained in the surface layers. The bulk of the nighttime respiration takes place in the bottom layers of the water column which do not receive the compensating photosynthetic oxygen. This may lead to a depletion of the oxygen from the bottom layers as the bloom progresses. (Moore-IVI)
W86-01197

BEHAVIOUR OF SUSPENDED SEDIMENTS AND MUDS IN AN ESTUARY,
Iwate Univ., Morioka (Japan). Dept. of Civil Engineering.
T. Umita, T. Kusuda, Y. Awaya, M. Onuma, and T. Futawatari.
Water Science and Technology, Vol. 17, No. 6/7, p 915-927, 1985. 19 Fig, 2 Tab, 9 Ref.

Descriptors: *Suspended sediments, *Mud, *Estuaries, Shear stress, Tidal effects, Sediment erosion, Sedimentation, Flocculation, Simulation, Model studies.

The fundamental behavior of suspended sediments and muds was investigated using an annular flume with the condition of cyclically changed shear stress. The results from two series of experiments showed that particle sizes which participate in the variation of suspended sediments were restricted to smaller sizes of the material. It was also found that the cyclically steady state was finally attained with respect to the suspended sediments as the tidal cycle repeated. In that state the suspended sediments were subject to three phenomena: erosion; deposition with dispersed state; and deposition with flocculation. A simple model of the suspended sediments in an estuary was developed and its behavior in a model estuary was simulated by using the fluxes of erosion and deposition in the experiment. That model well described the variation of the suspended sediments and muds. (Author's abstract)
W86-01231

MODELLING OF OXYGEN DEPLETION IN COASTAL WATERS,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
For primary bibliographic entry see Field 5C.
W86-01235

ROLE FOR A SIMPLE DISCRETE-TIME MODEL TO DESCRIBE DISPERSION IN AN ESTUARY,
Sydney Univ. (Australia). Dept. of Chemical Engineering.
T. Wood.
Water Science and Technology, Vol. 17, No. 6/7, p 991-1000, 1985. 2 Fig, 3 Tab, 9 Ref.

Descriptors: *Estuaries, *Dispersion, *Mathematical models, Tidal effects, Salinity, Model studies, Hawkesbury River, Australia, Model studies, River flow.

A simple discrete-time model is proposed to describe dispersion in an estuary, based on tidal exchanges between neighboring segments. A procedure for parameter estimation and model validation is described which can be implemented with a minimum of field measurements; and the application of the model is demonstrated with data collected from the Hawkesbury River system, near Sydney, Australia. The results indicate that the modelling procedure described is capable of producing useful predictions of the response of salinity distribution to changes in fresh water input and tidal amplitude. The method could be most useful in circumstances where limitations on experimental resources preclude the undertaking of a more detailed investigation. (Author's abstract)
W86-01237

TIDAL VARIATION OF SALT FLUX AND DISPERSION IN A POLLUTED ESTUARY,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
J. K. Park, and A. James.
Water Science and Technology, Vol. 17, No. 6/7, p 1001-1015, 1985. 10 Fig, 6 Tab, 18 Ref.

Descriptors: *Salinity, *Dispersion, *Tidal effects, *Estuaries, Tyne Estuary, England, Velocity, River flow, Tidal currents, Vertical shear, Model studies, Water quality.

Velocity and salinity data collected during the summer of 1983 in the Tyne estuary (England) are used to investigate the dominant mechanisms for the flux of salt and dispersion. The instantaneous salt flux arises mainly from the combination of velocity fluctuation with the tidal mean salinity, and the instantaneous dispersion results almost entirely from the combination of vertical oscillatory velocity and steady salinity. Of the net downstream salt flux, 92.4% is accounted for by the river discharge. The non-tidal drift appears to be of most importance in the net upstream salt flux. The estuary has a strong vertical salinity gradient and due to the strong secondary flow, has a uniform transverse gradient; thus, the dominant factor in the longitudinal dispersion arises from the vertical shear in the oscillatory tidal current. The dispersion coefficient is highly time-dependent within the tidal cycle as well as a function of distance. The importance of time-varying longitudinal dispersion coefficients are demonstrated in a water quality model by using the sensitivity analysis. (Author's abstract)
W86-01238

NITROGEN TRANSFORMATIONS IN THE BALTIC PROPER: DENITRIFICATION COUNTERACTS EUTROPHICATION,
Goeteborg Univ. (Sweden). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W86-01278

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3B. Water Yield Improvement

STATISTICAL-METEOROLOGICAL EVALUATION OF TWO OPERATIONAL SEEDING PROJECTS,
Illinois State Water Survey Div., Champaign.
F. A. Huff, S. A. Changnon, Jr., C. F. Hsu, and R. W. Scott.
Journal of Climate and Applied Meteorology, Vol. 24, No. 5, p 452-462, May, 1985. 6 Fig, 6 Tab, 3 Ref. NSF grant ATM 79-05007.

Descriptors: *Cloud seeding, *Weather modification, *Rainfall, *Kansas, *Oklahoma, Storms, Rainfall distribution, Statistical analysis, Wind.

As part of research concerned with operational seeding and evaluation techniques, analyses were made of two warm-season seeding projects involving rainfall enhancement: a 5-year (1975-79) aircraft seeding program conducted in 15 southwestern Kansas counties, and a ground generator seeding project conducted in 3 countries of northwestern Oklahoma in 1972-76. Data for 153 and 111 seeding days in Kansas and Oklahoma, respectively, were used. Rainfall data were obtained from the climatic raingage network of the National Weather Service. Seeding-day data were stratified according to meteorological parameters, including synoptic storm type, storm motion, and plume movement derived from the low-level wind field. Comparisons of 24-hour rainfall amounts in target and control areas were made. Movable controls determined from storm motions obtained from hourly radar data and upper-level winds were used to minimize control contamination by the seeding agent. In the southwestern Kansas operation, results indicated a target increase of 9% in the warm season rainfall, but this modest increase does not provide firm support for seeding enhancement considering rainfall natural variability, rainfall sampling deficiencies, and other sources of sampling error. In the Oklahoma project, no substantial support was established for seeding-induced rainfall from the ground generator operations.
W86-01136

AMSTERDAM WATER SUPPLY,
Amsterdam Water Supply (Netherlands).
For primary bibliographic entry see Field 5F.
W86-01260

3F. Conservation In Agriculture

EFFECTS OF IRRIGATION AND SOIL MANAGEMENT FOR FODDER CROPS ON ROOT ZONE CONDITIONS IN A RED-BROWN EARTH,
Animal and Irrigated Pastures Research Inst., Kyabram (Australia).
W. K. Mason, D. R. Small, and K. E. Pritchard.
Australian Journal of Soil Research, Vol. 22, No, 2, p 207-218, 1984. 6 Fig, 2 Tab, 23 Ref.

Descriptors: *Irrigation effects, *Soil management, *Fodder, *Root zone, Irrigation management, Soil structure, Crop rotation, Double cropping, Soil strength, Tillage, Organic matter, Corn, Lucerne, Soil water, Victoria.

The irrigated red-brown earths in northern Victoria have traditionally been considered unsuitable for intensive cropping owing to unstable soil structure. This experiment was established to determine whether management systems for continuous double cropping or crop/lucern rotations could be developed for these soils. A range of tillage levels, flood or furrow irrigation treatments and organic matter additions were imposed in December 1981. Soil strength, measured with a field penetrometer, has been significantly reduced by both surface soil management and deep ripping. The stability of surface soil aggregates has been significantly increased by reducing tillage, by avoiding the rapid wetting associated with flood irrigation and by the addition of organic matter. However, there has been no increase in rooting depth or activity of maize crops, as indicated by soil water extraction patterns and midday leaf water potential data, in response to the treatments imposed. However, lucerne rapidly developed an active root system, deeper in the profile than maize. This deeper root system increased the soil water supply for lucerne by approximately 50 mm. (Author's abstract)
W86-01032

WATER RETENTION, TRANSMISSION AND CONTACT CHARACTERISTICS OF LUDAS SAND AS INFLUENCED BY FARMYARD MANURE,
Haryana Agricultural Univ., Hissar (India). Dept. of Soils.
S. Kumar, R. S. Malik, and I. S. Dahiya.
Australian Journal of Soil Research, Vol. 22, No. 3, p 253-259, 1984. 3 Fig, 3 Tab, 14 Ref.

Descriptors: *Sand, *Water retention, *Transmission, *Manure, Permeability coefficient, Contact angle, Irrigation effects, Soil water.

A low retention capacity for water and a high percolation rate are the two major soil physical problems encountered in managing sandy soils. The soil-water contact property is one of the important factors influencing the infiltration of water into soils. Experiments were conducted in which small cylinders were filled to a depth of 20 cm with a sandy soil to which farmyard manure had been added up to a maximum rate equivalent to 846 t/ha. The cylinders were set in the ground and kept moist. At the end of 10 months samples were taken for measuring water retention and saturated hydraulic conductivity as well as the rate of horizontal infiltration for 0.01 M CaCl2 and alcohol. An apparent contact angle was calculated from the last two measurements. Manure application caused a progressive increase in the volume of water retained at a given suction, together with a small increase in available water. Hydraulic conductivity was decreased. Cumulative horizontal infiltration of 0.01 M CaCl2 decreased markedly with increase in manure applied. This decrease is attributed mainly to an increase in the contact angle. Increased water retention at all pressure potentials with manure applications means an increased water storage capacity of the sand. Decreased hydraulic conductivity, penetration coefficient and infiltration rate with manure application mean coverage of relatively larger areas under surface irrigation with a given quantity of irrigation water in improved sand as compared to control sand. (Moore-IVI)
W86-01033

OPTIMIZATION OF A SPATIALLY VARIABLE RESOURCE: AN ILLUSTRATION FOR IRRIGATED CROPS,
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
E. Feinerman, E. Bresler, and G. Dagan.
Water Resources Research, Vol. 21, No. 6, p 793-800, June, 1985. 2 Fig, 2 Tab. 26 Ref, 3 Append.

Descriptors: *Optimization, *Crop yield, *Irrigation effects, Corn, Decision making, Water supply, Spatial distribution, Variability.

Economic optimization of a resource which is space dependent and displays irregular spatial variation was investigated. The resource (yield) of an entire field is regarded as a random variable which depends on a random function on the one hand, and a control variable on the other hand. The study focuses on the question of how economically efficient levels of relevant control variables may vary as a function of random spatial variability of resources, taking into account the decision maker's attitude to risk. A general approach to cope with the above question is developed, and the effects of uncertainty on the levels of the optimal control variables are investigated by comparing a deterministic case with two uncertainty levels of decision making: risk neutral and risk averse. Following the general methodology, expectation value and variance of average yield are first approximated by Taylor series expansion and then closed-form solutions are obtained for a specific, exponential, yield production function. Subsequently, the general analysis is illustrated for the example of irrigated corn, the only control variable being water quantity, and with corp yield a spatial random function in the plane. The results suggest that the impact of random soil properties on optimum level of water application might be substantial. Hence it is generally worthwhile to account for spatial variability in optimizing level of irrigation or similar control variables. (Author's abstract)
W86-01070

UNCERTAINTY ANALYSIS OF WATER RESOURCE USE IN DHORA RESERVOIR COMMAND AREA,
Govind Ballabh Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Agricultural Economics.
J. Kumar, and V. H. Sharma.
Indian Journal of Power and River Valley Development, Vol. 33, No. 11, p 397-400, November, 1983. 2 Tab.

Descriptors: *Dhora Reservoir command area, *India, *Water management, Rainfall, Crop yield, Irrigation efficiency, Nitrogen, Crop production, Rice, Wheat, Sugarcane.

The Dhora Reservoir command area comprises 42138 hectares in the districts of Nainita, Bareilly and Rampur (India). The objectives of the present study were to find out probability distributions of fortnightly rainfall; to estimate fortnightly inflow of water into Dhora Reservoir over time; to prepare an optimal water resource plan for the Dhora Reservoir command area at different probable water suppy levels; and to find out optimum long run water resource plan for the Dhora Reservoir command area. The present use of nitrogen in the command area is concluded to be below optimal levels. It should be increased to three times that of the existing level in order to obtain maximum crop production with the available irrigation water. According to the long run plan developed on the basis of uncertainty analysis with respect to rainfall and, in turn, availability of water in Dhora Reservoir, the area located in the Dhora command to paddy, wheat, sugarcane, 34.70, 35.90, and 24.52% of total cropped area respectively, should be changed to 35.04, 35.39, and 25.00% of the cropped area respectively. The local varieties of paddy should be grown in the entire paddy area if the supply level of nitrogen remains at the existing level. At increased supply levels of nitrogen, the entire paddy area should be occupied by high yielding varieties. The nitrogen and irrigation water used for different crops should be adjusted over time, after observing the actual rainfall situation. The adoption of long run plans along with adjustments in cultural practices is expected to increase crop production in the area by 46.99% at existing nitrogen supply levels and by 99.27% without nitrogen constraint over the existing level of production. (Baker-IVI)
W86-01220

AGRICULTURAL AND ECOLOGICAL FEATURES IN THE EXPLOITATION OF IRRIGATED GROUNDS AND MEANS OF INCREASING THEIR PRODUCTIVITY (AGROEKOLOGICHESKIE OSOBENNOSTI ISPOL'ZOVANIYA OROSHAEMYKH POCHV I PUTI POVYSHENIYA IKH PROIZVODITEL'NOSTI),
M. P. Babayev.
Izvestiya Akademii Nauk Azerbaydzhanskoy SSR Seriya Biologicheskikh Nauk, No. 3, p 29-34, 1983. 1 Fig, 13 Ref.

Descriptors: *Agriculture, *Irrigation practices, *Kura-Araxin Valley, *Azerbaijan S.S.R., Irrigation water, Fertilization, Cultivation, Crop production.

To improve the productivity of the soils in the Kura-Araxin valley of Azerbaijan systematic investigations of the irrigational areas should be carried out. Irrigational soils with similar ecologic features should be categorized for appropriate exploitation.

In addition to the usual agricultural procedures, surveillance of the quality of irrigational waters, including suitable purification of wastewaters and application of local fertilizers, should be focused on. Long range cultivation under irrigational conditions should generate fertile soils with an increased productivity of cotton, grain, rice and perennial grass by 60-70%. (Erdelyi-IVI)
W86-01258

INFILTRATION FROM A TRICKLE SOURCE IN A HETEROGENEOUS SOIL MEDIUM,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 2G.
W86-01295

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

INCREASE OF THE EFFECTIVENESS OF USING THE HYDROPOWER RESOURCES OF THE ENISEI RIVER,
For primary bibliographic entry see Field 6B.
W86-00986

STOCHASTIC OPTIMIZATION OF A MULTIRESERVOIR HYDROELECTRIC SYSTEM: A DECOMPOSITION APPROACH,
Centro de Pesquisas de Energia Electrica, Rio de Janeiro (Brazil).
M. V. F. Pereira, and L. M. V. G. Pinto.
Water Resources Research, Vol. 21, No. 6, p 779-792, June, 1985. 14 Fig, 2 Tab, 33 Ref, 1 Append.

Descriptors: *Stochastic process, *Optimization, *Multireservoir networks, Hydroelectric power, Algorithms, Reservoirs, Electric powerplants, Cost analysis.

The objectives of the optimal operation of a hydrothermal generating system is to determine a generation schedule for each plant in the system that minimizes the expected operation cost for the planning period. The availability of limited amounts of hydroelectric energy, in the form of stored water in the system reservoirs, makes the optimal operation problem very complex because it creates a link between an operating decision in a given stage and the future consequences of this decision. A computational scheme that is able to determine at each stage the most economical generation decision for each plant of a hydrothermal system is presented. The algorithm is based on the stochastic extension of Benders decomposition and can be implemented from already existing operation models. The results can be used in the weekly or monthly generation scheduling activities in real-time operation. The algorithm supplies at each iteration an upper and lower bound to the optimal solution, allowing an efficient trade-off between computational effort and accuracy. The algorithm can accomodate any kind of stream-flow model because the transition probabilities at the bifurcations can be specified at will. A case study with four reservoirs was used to illustrate in detail the application of the algorithm. Its performance was further assessed with an example with 37 reservoirs. (Moore-IVI)
W86-01069

WATER QUALITY AND REGIONAL WATER SUPPLY PLANNING,
Corps of Engineers, San Francisco, CA. South Pacific Div.
A. J. Lauwaert.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 253-267, July, 1985. 1 Fig, 6 Tab, 4 Ref, 1 Append.

Descriptors: *Florida, *Lake Okeechobee, *St. Lucie County, *Water quality control, *Water supply development, Irrigation water, Runoff, Phosphorus removal, Flow-ways, Canals.

Canal 131 was intended to convey irrigation water supply to Martin and St. Lucie counties in Florida. The canal would be a direct access to Lake Okeechobee and would connect the lake to existing Canals 23-25 in St. Lucie County. Backflow would return surplus rainfall runoff to Lake Okeechobee from the St. Lucie County canals. The Canal 131 Flow-way Plan provides a flow-way area north of Canal 131 where surplus runoff could be diverted and detained. The intent of the flow-way plan is to create a seasonal wetland community for the removal of phosphorus from backflow into the lake. A method for sizing a flow-way to remove phosphorus from surplus rainfall runoff is presented. A 6.65 sq mi (17.22 sq km) flow-way with minimal additional management techniques is economically and environmentally desirable. The plan will protect groundwater supplies by returning captured surface runoff stored in Lake Okeechobee for irrigation water supply and reduce the need for obtaining irrigation requirements from groundwater sources. Diverting nontidal flows, which previously carried runoff into the St. Lucie Estuary, will improve surface water quality in the estuary, enhancing fish habitat. (Moore-IVI)
W86-01101

OPERATION AND EFFICIENCY OF AUTOMATICALLY OPERATING WEIR STRUCTURES - A CONTRIBUTION TO CLEANER WATERS,
Technische Univ. Braunschweig (Germany, F.R.). Leichtweiss-Inst. fuer Wasserbau und Grundbau.
E. Macke.
Water Science and Technology, Vol. 17, No. 6/7, p 1211-1221, 1985. 8 Fig, 6 Ref.

Descriptors: *Storm runoff, *Weirs, *Automation, *Storm sewers, Water quality control, Storm wastewater, Impounding head, Combined sewer overflows.

The automatically operating weir structures presented are simple, largely maintenance-free structures which, when used as control elements in storm overflows, offer considerable advantages over the fixed weir sills. Irrespective of the intensity of rainfalls, these weirs do not discharge any surplus water into the receiving water, unless a maximum possible water level has been reached, which is then maintained at a virtually constant level until the floods subside. The maximum possible water level, the so-called impounding head, will be determined in such a way that, on the one hand, the sewer capacity will be fully utilized, and, on the other, any undesirable backwater in the sewer system can be precluded. The weirs are not only suited for installation in new structures, but may also be integrated in existing ones. Time and cost consuming constructional measures can be dispensed with, as the weirs, owing to their configuration (they are composed of individual segments), can be passed through the existing manholes. They allow considerable additional sewer capacities to be activated, in particular in low-head sewer systems, so that the installation of high-cost retaining basins, which normally require a high degree of maintenance, can either be limited or dispensed with altogether. As the receiving water will be affected only when a given impounding head has been reached, the amount of combined sewage discharged can be reduced to a minimum. (Author's abstract)
W86-01254

STORMWATER MANAGEMENT EMPHASIZES SOFT IMPROVEMENTS,
Fort Collins Stormwater Utility, CO.
M. Engomoen.
Public Works, Vol. 16, No. 7, p 66-67, July, 1985. 3 Fig.

Descriptors: *Drainage systems, *Fort Collins, *Colorado, *Storm runoff, Management, Planning, Design criteria, Land use, Drainage canals, Surface drainage, Grassed waterways.

The focus of the Fort Collins (Colorado) stormwater utility is the identification and management of storm drainage systems. These systems contain a wide range of individual elements including soft features such as natural drainageways, creeks and rivers, man-made lakes, canals, and grass-lined open channels. By placing emphasis on design concepts for soft drainage features before development occurs, major design flows can be determined and right of way needs identified well in advance of other land planning activities. Beyond the economic and open space advantages of soft improvements, the use of grass-lined channels and detention areas offers some environmental benefits. Basin master plans also identify the need for some hard drainage improvements. Fort Collins' committment to soft improvements is illustrated by recent changes in the storm drainage maintenance program. Designing and constructing natural waterways, grasslined and landscaped open channels, and detention areas are only the first step. Effective annual maintenance must be a part of the plan. The committment to soft improvements has resulted in improved maintenance procedures and design standards and it has triggered increased coordination with other city departments to encourage open space and recreational use of drainageways. (Baker-IVI)
W86-01315

4B. Groundwater Management

QUANTITATIVE ANALYSIS OF THE LASSEN HYDROTHERMAL SYSTEM, NORTH CENTRAL CALIFORNIA,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W86-01077

GROUND-WATER RESERVOIR OPERATION FOR DROUGHT MANAGEMENT,
Roger Williams Coll., Bristol, RI. Dept. of Civil Engineering.
R. S. Gupta, and A. S. Goodman.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 303-320, July, 1985. 4 Fig, 5 Tab, 14 Ref, 1 Append.

Descriptors: *Drought management, *Groundwater reservoirs, Groundwater management, Model studies, Groundwater movement, Geohydrology, Conjunctive use, Infiltration, Wells, Pumping, Cutoff cores, Hydrodynamics.

A hydrodynamic groundwater model is integrated with a multi-level management model to formulate a composite model for investigating ground-water reservoir operation for drought management. The hydrodynamic model solves the three-dimensional groundwater flow equation by the finite difference method. A U.S. Geological Survey Model with extensions is used for this purpose. For given hydrogeological conditions, the management model assists the planner to design a system for augmenting low streamflows according to stipulated water supply requirements, by: (1) Arranging the wells within each unit of a multiaquifer system; and (2) establishing the withdrawal pattern for the system. Sensitivity analyses are made of the parameters pertaining to the conjunctive use of water by applying the model to the Mashipacong Island area in the Delaware Basin. The studies consider the hydrogeological properties of the aquifer and streambed, artificial measures to reduce induced infiltration, and arrangements of wells and pumping schedules. Among the infiltration reduction measures studied, a vertical semi-pervious core extending through the entire thickness of the aquifer can reduce losses from over 60% to less than 40%. Such a cutoff core, constructed by the slurry trenching process, may be economically attractive. (Author's abstract)
W86-01105

RESPONSE OF GROUNDWATER LEVELS TO RAINFALL AND TO LEAF GROWTH OF FARM PLANTATIONS NEAR SALT SEEPS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Groundwater Research.
For primary bibliographic entry see Field 2F.

W86-01290

HYDROLOGY OF BANK GROUNDWATER WITHDRAWALS IN THE NETHERLANDS,
Ministerie van Volksgezondheid en Milieuhygiene, Leidschendam (Netherlands).
C. R. Meinardi, and G. Grakist.
Journal of Hydrology, Vol. 78, No. 1/2, p 151-163, May, 1985. 6 Fig, 1 Tab, 5 Ref.

Descriptors: *Hydrology, *Groundwater extraction, *Netherlands, *Groundwater recharge, *Groundwater movement, Model studies, Water pollution prevention, Water resources development, Geohydrology.

Bank filtration in the strict sense is not applied in The Netherlands. However, several well fields are situated at some distance from generally infiltrating rivers. These extractions have both the features of groundwater withdrawal and of river-induced recharge. In the past, problems were considered from the viewpoint of groundwater. Examples are land subsidence, attraction of brackish groundwater, clogging of wells and treatment required for poor groundwater quality. At present, especially the quality transformation between parent river and wells is investigated. Use is made of the convolution integral, including an impulse response function, derived from the frequency distribution of travel times of river water in the subsoil. Travel times for each particular well field are computed using numerical modelling of the geohydrological situation. No generally accepted protection strategies and design criteria have been developed yet. Preventing entry of polluted river water to the subsoil is not feasible. The emphasis should be put on adequate design, monitoring and appropriate operation of the well fields in order to keep the quality of the pumped water at acceptable standards. (Author's abstract)
W86-01298

4C. Effects On Water Of Man's Non-Water Activities

BENTHIC FAUNAS AND FOOD RESOURCES OF INSECTS IN SMALL NEW ZEALAND STREAMS SUBJECTED TO DIFFERENT FORESTRY PRACTICES,
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
M. J. Winterbourn, and J. S. Rounick.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2148-2152, 1985. 1 Fig, 3 Tab, 8 Ref.

Descriptors: *Forest management, *Benthos, *New Zealand, *Streams, *Aquatic insects, *Foods, Clearcutting, Environmental effects, Mayflies, Stoneflies, Ecology.

Clearfelling, following by burning and log removal, appeared to result in more homogeneous channels with few debris dams and stable obstructions; some of these changes affected the aquatic insects, but no species was restricted only to modified streams. This study of 6 catchments in the Maimai experimental area, North Westland, New Zealand, provides further support for the contention that New Zealand stream faunas are characterized by generalists with broad and flexible habitat and food requirements. Kick-sampling of bed materials yielded 64 spp of invertebrates, 33-49 per stream; all pairs of streams had at least 26 spp in common. Relative abundance of species differed between streams and was associated with differences in substrate and flow conditions, some of which were consequences of catchment modification. Faunal similarity was greatest among three streams with gravelly beds, relatively low flow, and closed canopies. Kinds of allochthonous organic matter differed among the streams; the most disparate occurred in stream 214 where coarse material was predominantly grass. Fine detritus of either plant or obscure origin was the principal material ingested by benthic insects. Mayfly (Deleatidium and Zephlebia) guts were dominated by amorphous material and fine inorganic particles, whereas small stoneflies (Spaniocera, Zelandobius, Austroperla) ingested mainly allochthonous detritus including fragments of leaf and wood. Insect larvae from stream 214 contained variable amounts of filamentous algae and/or diatoms. Stable carbon isotope ratios (C-13/C-12 expressed as delta C-13) of fine particulate organic matter from all 6 streams ranged from -27.4 to - 28.4%, indicating a primarily terrestrial origin. Delta carbon-13 values were comparable for closed-canopy streams, but insects, including predators, from open-canopy streams were relatively depleted in C-13, and in stream 214 the values approximated that for algae (-33.3%) from that stream. (Rochester-IVI)
W86-00927

SIMULATOR FOR WATER RESOURCES IN RURAL BASINS,
Agricultural Research Service, Temple, TX.
For primary bibliographic entry see Field 2A.
W86-01049

DETERMINATION OF URBAN FLOOD DAMAGES,
Corps of Engineers, Baltimore, MD. Baltimore District.
For primary bibliographic entry see Field 6E.
W86-01102

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

DEVELOPMENT AND USE OF AN EMPIRICAL MODEL FOR DISSOLVED OXYGEN IN THE RIVER DON, ABERDEENSHIRE,
Water Research Centre, Stevenage (England).
J. S. Alabaster, J. C. Allan, and C. W. M. Sim.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2244-2247, 1985. 2 Tab, 9 Ref.

Descriptors: *Model studies, *Dissolved oxygen, *River Don, *Scotland, Biological oxygen demand, Benthos, Nutrients, Streamflow.

Dissolved oxygen (DO) levels in relation to biochemical oxygen demand (BOD) loading were predicted for the lower River Don (Scotland) using an equation derived from Streeter and Phelps (1925). During September 1981 the flow of the river was close to the 95th percentile value and the BOD load remained relatively constant; validation of the model was carried out for this period. A multiple regression of the BOD decay coefficient (per km) (k sub 1) on flow and temperature explained 87% of the variation in k sub 1. Splitting the data within the different flow bands to distinguish those that were associated with BOD loads that were either higher or lower than averaged showed that both k sub 1 and the respiration rate (oxygen demand) of growths attached to the bed of the stream (g/cu m/km) (R) increased with increase in load. The predicted DO for the validation period at one station was 5.7 mg/l; the observed DO was 5.1 mg/l. The observed BOD was slightly (1.3 mg/l) higher than predicted and the values of k sub 1 and R were also somewhat higher than those calculated for the years 1973-79. There was a reduction in k sub 1 with increase in flow, although low temperature coinciding with high flow was also a minor contributing factor. Loads also influenced k sub 1. The maximum values of R occurred not at the highest flows (7.6 and 8.7 cu m/sec), but at 6.6 cu m/sec, perhaps partly because low water velocity at low flow reduced the mass-flow of nutrients below that limiting the growth of benthic organisms. (Rochester-IVI)
W86-00937

ECOLOGICAL WATER QUALITY POLICY: AN ATTEMPT AT CONCEPT CLARIFICATION AND A PLEA FOR THE USE OF BIOLOGICAL ECOSYSTEM PARAMETERS,
Ministerie van Welzijn, Volksgezondheid, en Cultuur, Amsterdam (Netherlands).
A. Goedmakers.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2277-2280, 1985. 10 Ref.

Descriptors: *Ecology, *Ecological effects, *Water quality criteria, Water quality standards, Policy making, Physicochemical characteristics, Water chemistry, Indicators, Bioindicators.

Definitions, parameters, and standards for an ecological water quality policy are discussed. An ecological water quality policy is a water quality policy based on the ecosystem, and is not necessarily directed toward improvement of water quality as it would be defined for human health or industrial use as is currently done. Ecological parameters are those that describe the ecosytem; physical, chemical, or biological parameters may be employed in setting ecological standards. Although biological parameters have not been as accepted in standard setting as physico-chemical ones, their properties for description of the ecosystem make them indispensable for an ecological water quality policy. Biological parameters lack many of the technical problems associated with physico-chemical standards, but it is unlikely that one biological standard will be universally applicable, hence a differentiated approach to standard setting will be necessary. (Rochester-IVI)
W86-00941

USING SEVERAL INDICES FOR BIOLOGICAL ASSESSMENT OF WATER QUALITY IN RUNNING WATER,
Limburg Water Pollution Control Authority, Roermond (Netherlands).
H. H. Tolkamp.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2281-2286, 1985. 1 Fig, 1 Tab, 17 Ref.

Descriptors: *Bioindicators, *Water quality, *River Geul, *Netherlands, Assessments, Statistical analysis, Species distribution, Species composition.

Samples (113) were collected in the drainage area of the River Geul (The Netherlands), and 88 of them were used in a comparison of various biological indices for water quality assessment. The Trent Biotic Index, Indice Biotique (French Biotic Index), Indice de Qualite Biologique Globale, the Chandler score, Biological Monitoring Working Pary Score, Saprobic Index, Quality Index (K sub 135), Expanded Biotic Index, and modifications of some of these indices were all calculated for all samples, which had been obtained from lowland, upland, and spring or small stream locations. The resulting figures for each index were divided into 10 classes so that frequency histograms of the same number of intervals were obtained for all indices. Most of the sites used in the calculations had fairly good to good water quality; several indices were clearly inadequate for identifying the pollution level at the sites studied. Several gave an underestimation of water quality, and at least one (K-index) appeared to overestimate the quality of the stream waters. The use of 10-class histograms does not provide a means of obtaining absolute pollution levels, but creates a means of comparison from one sample to another. To know which level of water quality is the best achievable for each stream reach, it is necessary to know what the natural running water community for that site would look like. Most biotic indices or saprobic indices cannot be translated into each other. The right assessment system should be chosen, fit to be used under local conditions, with a well-defined achievable maximum or pollutional range. (Rochester-IVI)
W86-00942

USE OF BACTERIA ATTACHED TO SUBMERGED MACROPHYTES AND GLASS SLIDES AS INDICATORS OF AN INCREASING WATER POLLUTION,
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Bodenkunde und Standortslehre.
For primary bibliographic entry see Field 7B.
W86-00943

CHARACTERIZATION OF DIFFERENTLY POLLUTED PONDS BY SUBMERGED MACROPHYTES AND VARIOUS DENITRIFYING BACTERIA,
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Bodenkunde und Standortslehre.
F. Schmider, and J. C. G. Ottow.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2303-2308, 1985. 2 Fig, 2 Tab, 7 Ref.

Descriptors: *Bioindicators, *Aquatic plants, *Bacteria, *Germany (Federal Republic), *Nitrogen removal, Species distribution, Indicators, Species composition, Microorganisms.

Submerged macrophytes and denitrifying bacteria composition reflected pollutional level at four sites in West Germany. An oligotrophic well near Stuttgart-Busnau and three, increasingly eutrophic, natural ponds in the Rhine Valley (Baggersee - oligotrophic, Festungsgraben - mesotrophic, and Koenigsee - eutrophic) were chosen. Chara vulgaris, Potamogeton nodosus, and P. trichoides occurred only in Baggersee, whereas Ceratophyllum demersum, Hippuris vulgaris, Nuphar lutea, and Utricularia vulgaris were found abundantly in the mesotrophic and eutrophic ponds. Hottonia palustris and Hydrocharis morsus-ranae were found only in Koenigsee. In Koenigsee prototrophic denitrifying organisms (Acinetobacter-Moraxella-Alcaligenes spp) constitutued the main part of the denitrifying flora. Altogether, 92 denitrifying bacteria were isolated, and the qualitative determination confirmed the quantitative results. Pseudomonas fluorescens and Vibrio spp were more frequent in the oligotrophic well and Baggersee, whereas P. alcaligenes and Aeromonas spp were mainly distributed in Koenigsee. Assessment of rapid changes of pollution level by chemical parameters should be supplemented by bio-indicators, such as the submerged macrophyte and microbial group analyses used here. (Rochester-IVI)
W86-00944

DIATOM COMMUNITIES OF THE POLLUTED RIVERS OF CENTRAL POLAND (LES COMMUNAUTES DES DIATOMEES DANS LES RIVIERES POLLUEES DE LA POLOGNE CENTRALE),
Lodz Univ. (Poland). Inst. of Environmental Biology.
For primary bibliographic entry see Field 5C.
W86-00947

SEDIMENT AS A RECORD OF COPPER POLLUTION IN LAKE ORTA,
Istituto di Ricerca sulle Acque, Milan (Italy). Reparto Sperimentale di Idrobiologia Applicata.
For primary bibliographic entry see Field 5B.
W86-00958

USE OF AQUATIC BRYOPHYTES TO MONITOR HEAVY METALS POLLUTION OF FRESHWATERS AS ILLUSTRATED BY CASE STUDIES,
Metz Univ. (France). Lab. d'Ecologie.
For primary bibliographic entry see Field 7B.
W86-00962

USE OF LIMNOCORRALS FOR PESTICIDE TOXICITY STUDIES: EFFECT ON ZOOPLANKTON COMPOSITION AND DYNAMICS,
Tel-Aviv Univ. (Israel). Inst. for Nature Preservation Research.
A. Gasith, and A. S. Perry.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2432-2436, March, 1985. 3 Fig, 1 Tab, 5 Ref. FAO/IAEA Contract No. 1724/R4/SD.

Descriptors: *Limnocorrals, *Bioindicators, *Zooplankton, *Pesticide toxicity, Pesticides, Toxicity, Parathion, Fish, Water pollution effects.

The potential use of small limnocorrals for pesticide toxicity studies was investigated. The experiment was carried out using eight PVC limnocorrals anchored in a fish pond. The experiment lasted 10 days, with parathion introduced on days 0 (100 mg), 3 and 6 (50 mg). The limnological conditions in the fish pond and the limnocorrals were typical of a highly eutrophic system in summer. The initial residue concentration of parathion in the treated limnocorrals averaged 25-30 ppb. Between applications, concentrations of parathion in the water rapidly declined to 40%, 11-21%, and 23%, of the initial concentration after the 1st, 2nd, and 3rd applications, respectively. In the absence of fish and no exposure to parathion the population of the cladoceran species in the limnocorrals increased 2-4 fold within 24 hours. Exposure to parathion caused elimination of the dominant cladoceran species and sharp increases in the rotifer populations, within 24 hrs. In the presence of fish the response in the two limnocorrals was not uniform. In one limnocorral the cladoceran population declined and disappeared after 5 days. In the other limnocorral the cladoceran population initially declined but recovered after 2 days and became dominant thereafter. A comparison of the zooplankton species composition and dynamics in the parathion-free limnocorrals and the fish pond revealed a pronounced containment effect. Small enclosures may be useful for evaluation of the toxic effect of chemicals in short term experiments only. (Baker-IVI)
W86-00964

SOME ASPECTS ON ALGAL TOXICITY TESTS WITH NATURAL PHYTOPLANKTON,
Jyvaeskylae Univ. (Finland). Dept. of Biology.
V. Eloranta, and L. Halttunen-Keyrilainen.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2463-2468, March, 1985. 3 Fig, 1 Tab, 18 Ref.

Descriptors: *Phytoplankton, *Phytotoxicity, *Algae, Finland, Bioassay, Seasonal variation, Physical properties, Chemical properties, Nutrients, Biomass, Species composition, Temperature effects.

A three year project was started at the beginning of 1983 in which natural phytoplankton samples were taken from surface waters monthly or bimonthly from a natural, slightly eutrophic pond in the town of Jyvaskyla, Finland. The sensitivity of the algal communities to toxic compounds was examined under various conditions. Seasonal differences were indicated in the resistance of the phytoplankton to toxic effluents. No significant correlation was detected between the toxicity response of the samples and their chlorophyll content or their photosynthetic rate. The biomass markedly affected the response of phytoplankton to toxic chemicals, as well as species composition and temperature. The response of the phytoplankton to shock-discharges should be studied only by short term tests, when the situation is most natural and less complicated concerning, for example, the effects of nutrients in the sample water. (Baker-IVI)
W86-00969

RADIONUCLIDE CONTENT MEASUREMENT AND INTERPRETATION IN FISH FROM THE UPPER RHONE RIVER IN FRANCE (MESURE ET INTERPRETATION DES TENEURS EN RADIONUCLEIDES DE POISSONS DU HAUT-RHONE FRANCAIS),
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France). Service d'Etudes et Recherches sur l'Environnement.
L. Foulquier, B. Descamps, and Y. Baudin-Jaulent.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2470-2475, 1985. 1 Fig, 4 Tab, 9 Ref.

Descriptors: *Rhone River, *France, *Fish, *Radioisotopes, Nuclear powerplants, Radioactive wastes, Cesium radioisotopes, Cobalt radioisotopes, Zinc radioisotopes, Potassium radioisotopes, Manganese radioisotopes, Bioindicators.

The Rhone river basin includes 6 nuclear sites with a total generating capacity of 11,000 MWe. Samples taken by the Commissariat a l'Energie Atomique (CEA) were used to evaluate radiocontamination of fish by gamma emitters. The impact of fallout and of liquid waste discharge was selectively studied at the Bugey site (1 graphite-gas reactor and 4 PWRs). The constant natural radioactivity due to K-40 was about 2200 pCi/kg of fresh weight. Artificial radioactivity measured upriver from the plant was due to Cs-137s in the fallout (approx. 10 pCi/kg fresh weight). Immediately downriver, from December 1974 to March 1978, only Cs-137 (approx. 30 pCI/kg), Cs-134 and Zn-65 were measured. Thereafter, following divergence of the PWRs, Co-60 was measured at about 40 pCi/kg, Co-58 at about 250 pCi/kg and Mn-54 at about 30 pCi/kg fresh weight. These findings, consistent with the composition of waste releases, show that fish can be valid bioindicators. Their consumption represents only 0.04% of the maximum permissible dose. (Author's abstract)
W86-00970

WATER PLANTS, AN INDICATOR FOR RADIOACTIVE CONTAMINATION (WASSERPFLANZEN, EIN INDIKATOR FOR RADIOAKTIVE VERUNEINIGUNGEN),
Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
H. Hubel, and H. Herrmann.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2481-2485, March, 1985. 5 Tab.

Descriptors: *Aquatic plants, *Bioindicators, *Radioactive wastes, *Danube River, *Gundremming, *Germany (Federal Republic), Radioisotopes, Nuclear powerplants, Bioaccumulation, Fallout, Cooling water.

Waterplants are good indicators of radioactive contamination, even when the evidence in the surrounding water is absent. The presentation of the enrichment factors for radionuclides in waterplants represents a useful method of quantitative determination of these nuclides. On the grounds of the nuclide combination of the surface waters (Donau at Gundremmingen) and the cooling water composition from the Gundremmingen nuclear powerplant tests were undertaken, to determine the origin of these nuclides in the water plants. The results indicate that both the influence from fallout (formed through atomic weapon tests) and radioactive products for the Gundremmingen nuclear powerplant are evident. Although the inactivation (1977) and the consequent lessening of the activity from the Gundremmingen nuclear powerplant can be seen in the last three years (through 1982) the small fallout influence is still observable. Disregarding the exceptions, the radionuclide concentrations in the water plants are not correlated with their physical substrates. (Author's abstract)
W86-00971

MUTAGENICITY AND ORGANIC HALOGEN DETERMINATION IN BODY FLUIDS AND TISSUES OF RATS TREATED WITH DRINKING WATER AND PULP MILL BLEACHERY EFFLUENT CONCENTRATES,
Sentralinstitutt for Industriell Forskning, Oslo (Norway).
For primary bibliographic entry see Field 5C.
W86-00993

CONTRIBUTION TO THE DETERMINATION OF PARTICULATE ORGANIC CARBON IN WATER SAMPLES (EIN BEITRAG ZUR BESTIMMUNG VON PARTIKULAREM ORGANISCHEN KOHLENSTOFF IN WASSERPROBEN),
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
G. Proft.
Acta Hydrochimica et Hydrobiologica, Vol. 11, No. 6, p 631-636, 1983. 2 Tab, 13 Ref.

Descriptors: *Organic carbon, *Particulate matter, *Water analysis, Filtration, Oxidation, Photometry.

The method after Strickland and Parsons is modified for fresh water as follows: filtration on glass-fiber paper, oxidation with K2Cr2O7 in conc.

H2SO4 for 2 h at 130 C, dilution to 2.5 times the volume by aqua dest., centrifuging-off of the turbidity and extinction measurement at 445 nm against the blank value, the sample solution being balanced to the transmission of 100% (extinction = 0). Hence, the following calibration line holds for the concentration C and the quantity of oxidation solution Ox: C=E(1cm) c . 0.162 . Ox, C in mg filter. The oxidation solution contains 4.8 g K2Cr2O7 as dissolved in 20 ml aqua dest. and made up with con. H2SO4 to 1 l. With 5 ml of this solution one is able to determine 0.05-1 mg C/ filter. Calibration is performed with 125 mg/l glucose solution. Comparative investigations have shown a good agreement with elementary-analytically obtained measured values. The errors have been determined mainly by sampling. In the range of very small values one must take into account a blank value of the filter due to the adsorption of dissolved organic substances on the filter. (Author's abstract)
W86-01000

GAS-CHROMATOGRAPHIC DETERMINATION OF FREE VOLATILE FATTY ACIDS (C2 TO C6) IN PERCOLATION WATER OF HOUSEHOLD REFUSE DUMPING PLACES (DIE GASCHROMATOGRAPHISCHE BESTIMMUNG VON FREIEN FLUCHTIGEN FETTSAUREN (C2 - C6) IM SICKERWASSER VON HAUSMULLDEPONIEN),
VEB (B) Deponie, Potsdam (German D.R.).
H.-U. Kittelmann, L. Hartung, and S. Kruger.
Acta Hydrochimica et Hydrobiologica, Vol. 11, No. 6, p 647-655, 1983. 3 Fig, 3 Tab, 25 Ref.

Descriptors: *Wastewater analysis, *Fatty acids, *Leachates, *Landfills, Domestic wastes, Silage, Manure, Volatile compounds, Gas chromatography.

After extensive experiments aimed at determining the free volatile fatty acids (C2 to C6) in organically highly polluted percolation water of household refuse dumping places, a column packed with 10% Carbowax 20 M on Chromatron N-AW-DMCS after having been conditioned for five days at 270 C and subsequently covered with 10% hard wax proved optimum. At short retention times the investigated isomeric column pairs are completely separated. Equally favorable results were obtained also for liquid manure and silage extracts. The detection limits lie between 10 and 20 mg/l, the relative standard deviation is 20-30% in the range of the lower detection limit and 2-3% at 200 mg/l in the upper range. In the investigation of percolation waters with concentrations between 235 and 4300 mg/l reproducibility lies at a mean relative standard deviation of 0.5-2.8%. The technique is well suited for routine checking. (Author's abstract)
W86-01001

APPLICATION OF SIMPLE PRESERVING TECHNIQUES FOR WATER INVESTIGATIONS (ANWENDUNG EINFACHER KONSERVIERUNGSVERFAHREN FUR WASSERUNTERSUCHUNGEN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
B. Doll, D. Grether, and M. Doll.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 35-46, 1985. 7 Fig, 2 Tab, 12 Ref.

Descriptors: *Wastewater analysis, *Effluents, *Sample preservation, Temperature effects, Hydrogen ion concentration, Orthophosphates, Phosphates, Chemical oxygen demand, Organic carbon, Ammounium, Nitrates.

Samples taken from the influent and effluent of a biological wastewater treatment plant were immediately analyzed and investigated at different intervals within four weeks after sampling. They were stored in the dark at 277 and 293 K and at pH 2 and pH 12 each. None of the measures resulted in a correct stabilization or preservation of the samples: orthophosphate cannot be stabilized by any measure; the total phosphate need not be stabilized; the COD gives values which are still useful only at pH 2 and 277 K; TOC and DOC do not show useful results with any of the applied techniques; and the results are equally insufficient for ammonium and nitrate ions. In addition, differences occur in the behavior of the samples taken from the influent and effluent. In agreement with the results published in the literature, the chemical analysis has to be carried out within 6 hr after sampling. (Author's abstract)
W86-01009

ROLE OF THE DAPHNIA BIOASSAY IN THE ASSESSMENT OF THE QUALITY OF EFFLUENT DISCHARGES,
Yorkshire Water Authority (England).
G. M. Morris, and F. T. Buckley.
Water Pollution Control, Vol. 83, No. 4, p 539-546, 1984. 1 Fig, 7 Tab, 11 Ref.

Descriptors: *Water quality, *Daphnia, *Bioassay, Toxicity, Biological properties, Monitoring, Trout.

There is a need for a reliable, effective and simple biological method for determining the suitability of an effluent discharge containing highly toxic often unknown chemicals. A bioassay using Daphnia magna has recently been adopted as a BSI Standard which is the first method described for the biological testing of water quality. The Daphnia bioassay has several advantages, compared to the use of fish, especially the ease of culturing the much smaller Daphnia and the consequent savings in space and cost. From a survey of the literature and data available it appears that Daphnia magna and rainbow trout are equally susceptible to a wide range of toxicants. A successful demonstration has been outlined in the use of the Daphnia bioassay in the monitoring and control of discharges from a toxic waste landfill site. The bioassay is an acute test and the effect of sub-lethal and chronic damage cannot be assessed. Moreover, the true effect of any particular toxicant in the environment requires detailed investigation and research. Finally, several suggestions are made regarding the use of the bioassay and Daphnia in general. In particular one important use could be as a condition for inclusion in consents for the discharge of effluent into inland waters or public sewers. (Baker-IVI)
W86-01024

DETERMINATION OF SELENIUM IN SEWAGE SLUDGE USING AN ACID-DIGESTION BOMB AND FLUORIMETRY,
North West Water Authority, Warrington (England). Western Div.
I. A. Fleet, and G. S. Taylor.
Water Pollution Control, Vol. 83, No. 4, p 562-568, 1984. 3 Fig, 5 Tab, 34 Ref.

Descriptors: *Selenium, *Sludge, *Acid digestion bomb, *Fluorimetry, Spectroscopy, Acid digestion, Pollutant identification, Industrial wastewater, Domestic wastewater.

Selenium concentrations have been determined in samples of sludge taken from the major sewage-treatment works in the Liverpool and West Lancashire (England) conurbation. A number of these treat significant amounts of industrial effluent in admixture with domestic sewage and a considerable range of industrial activity is undertaken in their drainage areas. The concentrations of selenium found were not high, being broadly in agreement with data previously reported. Overall the combination of bomb digestion and fluorescence spectroscopy proved successful. In particular the bomb performed safely (over fifty digestions per bomb without mishap) and was consistently capable of almost total digestion. The bomb digestion described could prove valuable in the preparation of sludge for the estimation of other determinands and as a reference method when assurance of complete digestion is desirable. As is frequently the case when adapting analytical techniques to the determination of trace species in sewage sludges, the main obstacle was found to be the effect of the matrix. EDTA was the most suitable complexing agent but the standard additions method was necessary to cope with variations in the sludge cation matrix. The least satisfactory aspect of the procedure was the demand on the analysts' time and the development of a better system of matrix control to obviate the need for standard additions would be worthwhile. (Baker-IVI)
W86-01026

FLUX USE FOR CALIBRATING AND VALIDATING MODELS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
J. H. Wlosinski.
Journal of Environmental Engineering, Vol. 111, No. 3, p 272-284, June, 1985. 10 Fig, 3 Tab, 11 Ref.

Descriptors: *Water quality, *Model studies, *Calibration, *Validation, Dissolved oxygen, Simulation, DeGray Lake, Arkansas.

Predicted flux, or process rates, must be considered along with predicted state variables when calibrating or validating water quality models. Concentrating only on changes of state variables and ignoring predicted fluxes could result in the implementation of inappropriate management strategies. To illustrate this, the Corps of Engineers' one-dimensional reservoir water quality model, CE-QUAL-R1, was calibrated using data collected at DeGray Lake, Arkansas. Initial predictions of dissolved oxygen, using coefficient values obtained from the literature, were not satisfactory. Evaluation of the flux predictions for oxygen showed which processes were most important in regulating dissolved oxygen, and showed those that were incorrect when compared to measured values. During the ensuing calibration simulations, as the flux predictions were brought more in line with measured values, the predictions of dissolved oxygen improved markedly. (Author's abstract)
W86-01039

SEARCH FOR ACID-FAST BACILLI IN BOTTLED MINERAL WATERS,
Pisa Univ. (Italy). Ist. di Igiene.
G. Caroli, E. Levre, G. Armani, S. Biffi-Gentili, and G. Molinari.
Journal of Applied Bacteriology, Vol. 58, No. 5, p 461-464, May, 1985. 1 Tab, 7 Ref.

Descriptors: *Mycobacteria, *Mineral water, *Bottled water, Bacterial analysis, Italy, Public health.

Samples of bottled mineral water sold in Italy in accordance with the law on microbiological standards were examined for the presence of acid-fast bacilli. Eighty-four samples were tested, 11 with added carbon dioxide and 73 without. Acid-fast bacilli were found in 1 of the former samples and in 8 of the latter, a total of 10.7%. The mycobacterial count was always very low (2-3 cfu/l) except for one sample which showed large numbers of Mycobacterium sphagni. This finding was not confirmed in two following samplings of the same water. The other acid-fast bacilli isolated were: M. gordonae (four strains), M. flavescens (one strain), M. phlei (one strain) and Nocardia sp. (two strains) in two samples of different water. These bacilli are not thought to be normal component of the waters but are the result of incidental contamination. The risk of infection from drinking such waters can be regarded as irrelevant in hospitalized or immunologically compromised subjects who face a greater risk when using tap water for drinking or washing. (Author's abstract)
W86-01054

RAPID METHOD FOR THE ANALYSIS OF TRIHALOMETHANES IN WATER,
South Australia Engineering and Water Supply Dept., Salisbury. State Water Labs.
B. C. Nicholson, D. B. Bursill, and D. J. Couche.
Journal of Chromatography, Vol. 325, No. 1, p 221-230, May, 1985. 4 Fig, 4 Tab, 17 Ref.

Descriptors: *Trihalomethanes, *Water analysis, Gas chromatography, Electron-capture detection, Sample preservation, Halogenated hydrocarbons.

A rapid and precise method for the analysis of trihalomethanes (THMs) in water is described. Samples are extracted with methylcyclohexane and analyzed by gas chromatography using a short capillary column and electron-capture detection.

THMs elute with baseline separation in 1.25 min, and detection limits of 1 micro-g/l are readily achievable using 100-ml samples and 2 ml of solvent. Standards are prepared in the same way as samples by extraction of aqueous solutions to compensate for the relatively low extraction efficiencies which result from the low solvent to water ratio used. Ascorbic acid is a more effective sample preservative than sodium thiosulfate. (Author's abstract)
W86-01082

DETERMINATION OF TRACE AMOUNTS OF ORGANOPHOSPHORUS PESTICIDES AND RELATED COMPOUNDS IN SOILS AND SEDIMENTS USING CAPILLARY GAS CHROMATOGRAPHY AND A NITROGEN-PHOSPHORUS DETECTOR,
State Chemical Supervision Service, Soeborg (Denmark).
J. Kjolholt.
Journal of Chromatography, Vol. 325, No. 1, p 231-238, May, 1985. 5 Fig, 2 Tab, 18 Ref.

Descriptors: *Organophosphorus pesticides, *Sediment analysis, *Pollutant identification, Gas chromatography, Wastewater analysis.

A sensitive, selective and relatively precise method was developed for the determination of organophosphorus compounds in matrices with high contents of organic or biological material, and has been tested on soil and sediment samples. Homogenized samples are subjected to Soxhlet extraction with acetone-n-hexane and the extract is partitioned between methylene chloride and water. The extract of the combined methylene chloride phases is cleaned up by adsorption chromatography and analyzed by capillary gas chromatography using a nitrogen-phosphorus detector. Recoveries at the 10 ppb level are between 54.6 and 82.4% with standard deviations between 3.1 and 8.9%. Detection limits are between 95 and 220 ng/kg. With minor adjustments the method is applicable to wastewater and foodstuffs, for which the Soxhlet extraction step is not needed. The method is currently being used in a study of the dispersal of pollutants from a point source to a marine inlet. (Moore-IVI)
W86-01083

EVAPOTRANSPIRATION DERIVED FROM SATELLITE OBSERVED SURFACE TEMPERATURES,
Utrecht Rijksuniversiteit (Netherlands). Inst. voor Meteorologie en Oceanografie.
For primary bibliographic entry see Field 2D.
W86-01135

SUITABILITY OF DIFFERENT COUNTING VIALS AND LIQUID SCINTILLATORS FOR DETERMINING TRITIUM IN WATER (DIE EIGNUNG VERSCHIEDENER MESSFLASCHCHEN UND SZINTILLATORFLUSSIGKEITEN ZUR BESTIMMUNG VON TRITIUM IN WASSER),
Bundesanstalt fuer Gewaesserkunde, Coblenz (Germany, F.R.).
For primary bibliographic entry see Field 7B.
W86-01142

CYTOTOXICITY/GENOTOXICITY: THE APPLICATION OF CELL CULTURE TECHNIQUES TO THE MEASUREMENT OF MARINE SEDIMENT POLLUTION,
Washington Univ., Seattle. Coll. of Forest Resources.
For primary bibliographic entry see Field 5C.
W86-01158

QUANTITATIVE STRUCTURE ACTIVITY RELATIONSHIPS AND MIXTURE TOXICITY STUDIES OF ALCOHOLS AND CHLOROHYDROCARBONS: EFFECTS ON GROWTH OF DAPHNIA MAGNA,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Veterinary Pharmacology, Pharmacy and Toxicology.
For primary bibliographic entry see Field 5C.
W86-01160

LEACHATE ATTENUATION IN THE UNSATURATED ZONE BENEATH LANDFILLS: INSTRUMENTATION AND MONITORING OF A SITE IN SOUTHERN ENGLAND,
Aspinwall and Co., Shrewsbury (England).
H. D. Robinson, and J. L. Lucas.
Water Science and Technology, Vol. 17, No. 4/5, p 477-492, 1985. 5 Fig, 4 Tab, 15 Ref.

Descriptors: *Groundwater pollution, *Leachates, *Landfills, *Monitoring, Water pollution sources, Attenuation blankets, Unsaturated zone, Waste disposal, Anaerobic conditions, Hydrogen ion concentration, Chlorides, Organic compounds, Temperature effects, Gases, England.

In the United Kingdom great reliance is placed upon the attenuation of contaminants which occurs as leachate seeps through intergranular unsaturated zones beneath landfill sites. At a site in Southern England, the landfill design incorporated an engineered, semipermeable attentuation blanket, using locally available calcareous sands and silt, emplaced to a minimum depth of 6 m above the water table. Installation of over 100 sampling and monitoring instruments within this unsaturated zone before waste disposal began in June 1982 made it possible to obtain water samples from the saturated and unsaturated zones, gas samples from the unsaturated zone, and to measure soil water pressure, electrical conductivity, and temperature in situ, at 3 monthly intervals since this date, to allow movement and attenuation of decomposition products of solid wastes to be monitored. The unsaturated zone rapidly became anaerobic as a result of migration of landfill gases through it, well in advance of any leachate front. The high buffering capacity of the calcareous sand/silt mixture prevented reduction in pH-values, and high concentrations of ammonia did not occur, probably as a result of cation exchange processes. Migration of other leachate constituents occurred, with raised concentrations of chloride and organic constituents detected after 15 months. The rate of migration varied significantly between individual sites. Based on the total volatile acids to chloride ratio, methane fermentation processes are active at least in some regions of the unsaturated zone, but their efficiency may suffer from the combined effects of direct toxicity of fatty acids and relatively low temperature. (Moore-IVI)
W86-01177

F SPECIFIC RNA BACTERIOPHAGES IN SEWAGE: METHODOLOGY AND OCCURRENCE,
Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands). Lab. voor Zoonosen Lebensmittelmikrobiology.
A. H. Havelaar, W. M. Hogeboom, and R. Pot.
Water Science and Technology, Vol. 17, No. 4/5, p 645-655, 1985. 1 Fig, 7 Tab, 23 Ref.

Descriptors: *Bacteriophage, *Wastewater analysis, *Bioindicators, Viruses, Salmonella, Industrial wastewater, Hospitals, Food-processing industry, F specific bacteriophage.

F specific RNA (FRNA) bacteriophages are attractive models for the study of the fate of animal viruses in water treatment processes and pure cultures (MS2, f2) have frequently been used in model experiments. The use of indigenous FRNA phages has been hampered by the lack of selective enumeration methods. Usually, bacteriophages in sewage are enumerated by counting the number of plaques produced in a lawn of an Escherichia coli host strain. Both somatic and F specific phages will contribute to the count. A simple and highly selective method, based on a specifically constructed host strain of Salmonella typhimurium (WG 49, phage type 3 Nalr (F'42 lac :: Tn5)), was developed. Counts on this host strain normally originate exclusively from F specific phages, because there are few somatic Salmonella phages in most sewage samples. FRNA phage counts from natural sewage samples using this host strain are more reliable and higher than those obtained on E. coli hosts. F specific bacteriophages were detected in all sewage samples investigated in numbers ranging from 100 - 50,000 pfu/ml. Data are presented on the number and types of F specific phages in mixed domestic/industrial sewage; in poultry processing wastewater and in hospital wastewater. The potential of F specific phages as water quality indicators is discussed. (Author's abstract)
W86-01189

INACTIVATION OF HEPATITIS A VIRUS, OTHER ENTERIC VIRUSES AND INDICATOR ORGANISMS IN WATER BY CHLORINATION,
National Inst. for Water Research, Pretoria (South Africa).
W. O. K. Grabow, P. Coubrough, C. Hilner, and B. W. Bateman.
Water Science and Technology, Vol. 17, No. 4/5, p 657-664, 1985. 2 Fig, 2 Tab, 16 Ref.

Descriptors: *Viruses, *Bioindicators, *Chlorination, Bacteria, Bacteriophage, Residual chlorine, Wastewater treatment, Water treatment, Bacterial analysis, Chlorination.

Hepatitis A virus (HAV) and various indicator organisms were mixed together in autoclaved biofilter effluent and broth-enriched tap water, and the survival kinetics of individual organisms after the addition of chlorine were compared. Chlorine was present in the reaction mixtures predominantly in the form of combined residuals. HAV was enumerated by a most probable number dilution assay using PLC/PRF/5 liver cells for propagation of the virus and radioimmunoassay for its detection. In both reaction mixtures HAV survived longer than Escherichia coli, Streptococcus faecalis, poliovirus type 2, coxsackievirus B5 and reovirus type 3, while it was less resistant than coliphage MS2, coliphage VI (except in tap water), the simian SA-11 rotavirus and Mycobacterium fortuitum. The survival data indicate that viruses (including coliphages) tend to be relatively more resistant to combined chlorine residuals than bacteria, while bacteria tend to be relatively more resistant to free chlorine residuals than viruses. Coliform bacteria may thus be fairly reliable indicators of the virological safety of waters disinfected by free chlorine residuals, but not of waters disinfected by combined chlorine residuals, as in the case of the chlorination of wastewater or the chloramination of drinking-water supplies. The relatively high resistance to combined chlorine residuals of HAV and SA-11 virus (which is closely related to human rotavirus) emphasizes the shortcomings of methods available for virological water analysis because they do not detect HAV and rotavirus. The results support views that the virological safety of all chlorinated waters can be reliably monitored by means of practical indicator systems consisting of appropriate combinations of determinants such as the standard plate count, coliform bacteria, coliphages, acid-fast bacteria and fecal streptococci. (Author's abstract)
W86-01190

EFFECTS OF WATER QUALITY ON MICROPOROUS FILTER METHODS FOR ENTERIC VIRUS CONCENTRATION,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
M. D. Sobsey, T. Cromeans, A. R. Hickey, and J. S. Glass.
Water Science and Technology, Vol. 17, No. 4/5, p 665-679, 1985. 8 Tab, 9 Ref. EPA grant R806677.

Descriptors: *Viruses, *Humic acid, *Fulvic acid, *Suspended solids, *Filters, Water quality, Organic compounds, Particulate matter, Clay, Water analysis.

Model enteric viruses were concentrated from seeded samples of raw, finished and granular activated carbon (GAC)-treated waters and from GAC-treated waters supplemented with humic or fulvic acid or bentonite clay particles by adsorption to electropositive (Virosorb 1MDS) filters at pH 7.5 or electronegative (Filterite) filters at pH 3.5 with and without 5 mM added MgCl2, followed by elution with 0.3% beef extract in 50 nM

glycine at pH 9.5. Natural particulates in raw and finished waters had little effect on virus concentration efficiencies. Soluble organic compounds reduced virus adsorption efficiencies from both raw and finished waters compared to GAC-treated water, but the extent of interference varied with virus type and adsorption conditions. Humic and fulvic acids caused appreciable reductions in poliovirus and adsorption and recovery efficiencies with both types of filters. Fulvic acid caused greater reductions in virus recovery with Virosorb 1MDS filters than with Filterite filters. Fulvic acid interference with virus recovery by Filterite filters was overcome by the presence of 5 mM MgCl2. Although humic acid reduced virus recoveries by both types of filters, its greatest effect was on virus elution and recovery from Filterite filters. Bentonite clay enhanced poliovirus retention by both filter types as much as 8-fold. However, the presence of clay often interfered with elution of retained viruses from both filter types. Under some conditions, overall virus recoveries were considerably lower from water with clay than from clay-free control water. The results of this study suggest that high concentrations of soluble organic matter such as humic and fulvic acids and suspended solids such as bentonite clay may interfere somewhat with virus recovery by filter adsorption-elution methods. (Author's abstract)
W86-01191

APPLICATION OF INFORMATION ABOUT CONDUCTIVITY IN THE COMPUTING OF ION CONCENTRATIONS, ILLUSTRATED BY CERTAIN SURFACE WATERS SITUATED IN LOWER SAXONY,
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Stadtbauwesen.
W. Walther, M. Gorsler, J. Poltz, and D. Bock.
Water Science and Technology, Vol. 17, No. 6/7, p 833-841, 1985. 4 Fig, 3 Tab, 4 Ref.

Descriptors: *Conductivity, *Hydrogen ion concentration, *Lower Saxony, *Germany (Federal Republic), Lakes, Rivers, Water pollution, Water quality, Monitoring, Calcium, Salinity, Mathematical models.

Conductivity and pH value are two of the few properties of water which can be continuously recorded by electrodes. The electrical conductivity and pH value are continuously recorded by monitoring stations at important surface waters in Lower Saxony, Federal Republic of Germany. The data are directly transmitted to the surveillance center in Hildesheim. Estimates of concentrations of the most important ions in water were made by using mathematical models. The basis for the calculations are the conductivity and, in case of a eutrophic lake, the pH value as well. The methods are demonstrated by using data from the river Weser and from the shallow lake Dummer. The Weser is one of the main rivers in Lower Saxony and is characterized by a very high and fluctuating salinity. More than 90% of the salt pollution is caused by potash mine wastes. The salt concentrations can be estimated between monthly sampling using a mathematical model. The lake Dummer is polytrophic and highly productive. In spring, calcium concentrations decrease from about 80-90 mg/l to about 50-60 mg/l. Correspondingly the conductivity of the lake water varies between about 600 micro-S/cm and 400 micro-S/cm in summer. An attempt was made to calculate the actual calcium concentrations from the continuously measured pH value and conductivity. The investigations showed that it is possible to compute the concentrations of the most important solution constituents of surface waters from conductivity and pH values. The equations for calculating the ion concentrations are specific for each water system and even for each part of it. (Moore-IVI)
W86-01224

CONTINUOUS, AUTOMATIC DETECTION OF ORGANOPHOSPHATES AND CARBAMATES IN WATER UTILIZING ENZYME MICROCALORIMETRY,
National Inst. for Water Research, Pretoria (South Africa).
W. S. G. Morgan, P. C. Kuhn, and P. P. van Niekerk.
Water Science and Technology, Vol. 17, No. 6/7, p 855-865, 1985. 6 Fig, 1 Tab, 12 Ref.

Descriptors: *Organophosphate pesticides, *Carbamate pesticides, *Enzyme microcalorimetry, Pollutant identification, Cholinesterase, Insecticides, Automation, Computers.

An enzyme calorimetric method, employing immobilized cholinesterase to detect harmful levels of organophosphorus and carbamate insecticides in water, is described. Immobilized cholinesterase activity was assessed automatically in a microcalorimeter by analyzing its catalytic efficiency in hydrolyzing a substrate solution which was passed over the enzyme at regular time intervals. A microcomputer was used to automate the procedure and for data acquisition. The inhibitory effects of three organophosphorus and two carbamate pesticides upon cholinesterase were studied in order to evaluate the efficacy of the technique. (Author's abstract)
W86-01226

BIOLOGICAL ASSESSMENT OF WATER QUALITY IN RUNNING WATER USING MACROINVERTEBRATES: A CASE STUDY FOR LIMBURG, THE NETHERLANDS,
Limburg Water Pollution Control Authority, Roermond (Netherlands). Dept. of Hydrobiology.
H. H. Tolkamp.
Water Science and Technology, Vol. 17, No. 17, p 867-878, 1985. 7 Fig, 1 Tab, 16 Ref.

Descriptors: *Invertebrates, *Bioindicators, *Water quality, *Limburg, *Netherlands, Species composition, Streams, Biotic index.

To obtain suitable biological methods for evaluating water quality several methods were applied to the macroinvertebrate composition of streams in the southern region of the province of Limburg (the Netherlands). After evaluation of the results through comparison followed by elimination of unsuitable methods (e.g. Trent Biotic Index, Indice Biotique, Indice de Qualite Biologique Globale) four methods remained promising: the Saprobic-index, the Quality-index, the BMWP-aspt and the Chandler-aspt. A further selection of methods must be carried out in combination with a typological classification of the streams concerned, including a description of the achievable range for each method. To this end more research in the field of stream typology is needed, especially for the province of Limburg with its high diversity of streams. (Author's abstract)
W86-01227

ENUMERATING INJURED COLIFORMS IN DRINKING WATER,
Montana State Univ., Bozeman. Dept. of Microbiology.
M. W. LeChevallier, and G. A. McFeters.
Journal of American Water Works Association, Vol. 77, No. 6, p 81-87, June, 1985. 3 Fig, 1 Tab, 105 Ref. EPA grant R807092.

Descriptors: *Bacterial analysis, *Bioindicators, *Coliforms, *Drinking water, Water quality control, Water analysis, Bacteria.

Injury to indicator bacteria can result from a variety of sources, including chlorine and other disinfectants, heat, freezing, sunlight, pH, transition metals, antagonistic plate count organisms, and possibly other undefined chemical and physical parameters. Many factors can influence injury, including time and temperature of exposure, strain of organism, physiological state, concentration of nutrients, neutralization technique dilutent and sample methodology. Effective alternative methods exist that are specifically designed for enumerating injured total and fecal coliforms. Operators and managers should be aware of the reality of injured coliforms. Injured indicator bacteria exist in every aquatic environment studied and may represent about half of the coliforms present. Utilities should perform parallel coliform analyses using m-Endo and m-T7 agars to assess the extent of occurrence of injured coliforms. Epidemiological investigations should be performed to further evaluate the role of stressed indicator bacteria in outbreaks of waterborne disease. (Baker-IVI)
W86-01265

APPLICATION OF ACUTE BIOASSAYS IN EVALUATING THE TREATMENT OF COAL LIQUEFACTION WASTEWATERS,
Department of Energy, Pittsburgh, PA. Pittsburgh Energy Technology Center.
For primary bibliographic entry see Field 5D.
W86-01284

TEST INSTRUCTIONS FOR MEASURING THE MICROBIAL METABOLIC ACTIVITY IN WATER SAMPLES,
Deutscher Verein des Gas- und Wasserfaches e.V., Eschborn (Germany, F.R.).
U. Obst.
Fresenius's Zeitschrift fur Analytische Chemie, Vol. 321, No. 2, p 166-168, May, 1985. 7 Ref.

Descriptors: *Water analysis, *Bacterial analysis, *Bacterial physiology, *Metabolism, *Enzymes, Enzymatic activity, Physiology, Chromophores, Catabolism, Chemical analysis.

Direct measurements of microbial metabolic degradation have previously been proven successful for testing influence of wastewater on surface water, describing the quality of water, analyzing groundwater, and biological treatment. Tests for measuring eight different enzymatic activities were developed; these enzymatic activities of the microbial metabolism in water can be measured after an addition of chromogenic substrates and their turnover. After the reaction the concentration of the chromophoric group proportional to the enzymatic activity is determined photometrically. If the molar value of the chromophore in the original substrate is known and the reaction is linear, the enzymatic turnover can be calculated in percent of conversion per liter and hour. With these biochemical methods, it is possible to determine enzyme activities concerning the catabolism of polymer substrates, di- and monomer fragments resulting from it, and finally energy-delivering metabolic activities. The enzymatic activity tests are suitable for use in a standard laboratory as a supplement to chemical and biological analyses; they do not call for extensive effort or expensive equipment. (Collier-IVI)
W86-01302

STATISTICAL EVALUATION OF AN INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRIC METHOD FOR ROUTINE WATER QUALITY TESTING,
Geological Survey, Denver, CO.
J. R. Garbarino, B. E. Jones, G. P. Stein, W. T. Belser, and H. E. Taylor.
Applied Spectroscopy, Vol. 39, No. 3, p 535-541, May/June, 1985. 7 Fig, 10 Tab, 11 Ref.

Descriptors: *Spectroscopy, *Atomic emission spectrometry, *Atomic absorption spectrometry, *Molecular absorption spectrophotometry, *Inductively coupled plasma, *Emission spectroscopy, Metals, Trace metals, Water analysis, Chemical analysis.

In an interlaboratory test, inductively coupled plasma atomic emission spectrometry (ICP-AES) was compared with flame atomic absorption spectrometry and molecular absorption spectrophotometry for the determination of 17 major and trace elements in 100 filtered natural water samples. No unacceptable biases were detected. The analysis precision of ICP-AES was found to be equal to or better than alternative methods. Known-addition recovery experiments demonstrated that the ICP-AES determinations are accurate to between + or - 2 and + or - 10 percent; four fifths of the tests yielded average recoveries of 95-105%, with an average relative standard deviation of about 5%. (Author's abstract)
W86-01304

INVERTEBRATE BIOASSAYS WITH NORTH SEA WATER SAMPLES. I. STRUCTURAL EF-

FECTS ON EMBRYOS AND LARVAE OF SERPULIDS, OYSTERS AND SEA URCHINS,
Biologische Anstalt Helgoland (Germany, F.R.)
K. Klockner, H. Rosenthal, and J. Willfuhr.
Helgolander Meeresuntersuchungen, Vol. 39, p 1-19, 1986. 5 Fig, 1 Tab, 33 Ref.

Descriptors: *North Sea, *Bioassays, *Invertebrates, *Ocean dumping, Immature growth stages, Oysters, Sea urchins, Polychaetes, Titanium dioxide, Sludge, Water pollution effects, Waste disposal.

The initial approach and the first results of bioassay techniques testing North Sea water samples from various dump sites in the laboratory are reported. Special attention is given to detailed methodological descriptions because of the importance of various handling procedures as contributors to experimental background variability. The usefulness of larval bioassay with sea urchins, oysters and polychaetes in future control and effects monitoring studies is discussed. A titanium dioxide dumping site was sampled immediately after dumping and 10 hr after dumping. Samples were also taken in the sewage sludge deposition area in the intervals between the usual dumping activities, regardless of the exact dumping schedule. The preserved bioassay test organisms were inspected microscopically to count percentages of normal larval hatch in test water samples, reference water samples and laboratory aged control water samples. A significant suppression of larval development of Pomatoceros triqueter in the trail water of the titanium dioxide dump site was noted while the development of sea urchin larvae was still affected in the 10 hr surface samples. Hatching of all test organisms in bottom-water samples from the center of the sewage sludge dump site was affected to different degrees when compared to reference areas about 4 km north or 6 km northwest of the dumping area. Further verification is needed to minimize experimental background variability of the bioassay and to enlarge the catalogue of suitable effects criteria. (Baker-IVI)
W86-01318

5B. Sources Of Pollution

DISTRIBUTION AND DECOMPOSITION OF LIGNOSULPHONATES IN LAKE PAIJANNE, CENTRAL FINLAND,
Jyvaeskylae Univ. (Finland). Inst. for Environment Research.
K. Granberg, and J. Granberg.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2254-2258, 1985. 1 Fig, 5 Tab, 12 Ref.

Descriptors: *Lignin, *Lignosulfonates, *Lake Paijanne, *Finland, *Fate of pollutants, Pulp and paper industry, Industrial wastewater, Pollution load.

Loading and distribution of lignin compounds in Lake Paijanne, Finland, were calculated for the 1960's, 1982, and predicted for 1985. The lake has received varying amounts of lignin in wastes from pulp and paper plants on its shore. It has a highly irregular shape, so individual basins were considered separately. Decomposition of lignin was calculated based on the equation: C = C sub o x 10 to the -kt power, where C = lignin loading (tons/day) as Na-lignosulfonates after time t, C sub o = original lignin loading (tons/day), k = the decomposition coefficient, and t = time in days. Three different decomposition coefficients were used: k sub 1 = 0.00131/day for the period 1-100 days, k sub 2 = 0.0004/day for the period 100-365 days, and k sub 3 = 0.0003 for the period 365-1,000 days. A computer program was used that calculated lignin loading of each basin in tons/day and the ligonsulfonate concentration (mg/l) using lignin loading from the pulp mill (tons/day), basin volume (cu m), and mean discharge as inputs. Calculated lignin loads within the 9 basins of the lake were much higher in the 1960's (58.5 tons/day, lignosulfonates 4.2-26.8 mg/l) than in 1982 (14.2-54.1 tons/day, lignosulfonates 1.0-3.3 mg/l), but the levels predicted for 1985 are somewhat higher (17.5-65.1 tons/day, lignosulfonates 1.1-6.9 mg/l), with exact levels depending on which of three discharge assumptions is used. The higher loadings are related to the start-up of a new plant at Aanekoski contributing 62 tons/day lignin load. The results calculated here represent the steady-state situation; predicted results must therefore be confirmed by actual results obtained 2-3 yr after the prediction was made. (Rochester-IVI)
W86-00939

MODIFICATION OF THE RELATIVE IMPORTANCE OF THE CARBON BALANCE IN A POLLUTED BROOK AFTER A PERIOD OF SPATE (MODIFICATION DE L'IMPORTANCE RELATIVE DES FLUX DE CARBONE D'UN RUISSEAU POLLUE APRES UNE PERIODE DE CRUE),
Savoie Univ., Chambery (France).
D. Fontvielle, and B. Cazelles.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2270-2276, 1985. 3 Fig, 1 Tab, 17 Ref.

Descriptors: *Carbon balance, *Stream pollution, *High flow, Pollution load, Invertebrates, Biomass, DNA, Carbon dioxide, Sedimentation, Precipitation, Organic matter.

During seven months (October 1981 to April 1982), the carbon balance of an organically polluted brook was followed from the measure of several parameters: benthic and water organic load, macroinvertebrate biomass, DNA, CO2 production of the sediment and emergences. The results are interpreted in relation to the precipitation and to the stream discharge. It appears that the role played by the biological processes is negligible compared to the rate of the waste input or to the rate of the sedimentation. (Author's abstract)
W86-00940

SELF-PURIFICATION WITH CONTROLLED REDOX CONDITIONS,
Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer Hydrologie.
T. Frevert, and I. Baumgartner.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2310-2313, 1985. 1 Fig, 1 Tab, 6 Ref.

Descriptors: *Oxidation-reduction potential, *Wastewater treatment, *Chemical oxygen demand, *Self-purification, Hydrogen ion concentration, Anoxic conditions, Water treatment, Dissolved oxygen.

Using a specialized apparatus and mixtures of domestic sewage and activated sludge, pe/pH feedback control was compared with no control for chemical oxygen demand (COD) removal. Redox intensity set points (pe sub 7, ie, referred to pH 7) ranged from 5.5 (full aeration) to -4.3 (no oxygen input). COD removal rates ranged from 10 to the -1.93 power per day under fully aerated conditions to 10 to the -3.12 power under completely anoxic conditions. When pe was feedback controlled so that O2 input was restricted to a certain set point, dissolved oxygen (DO) concentrations at all set points < or = 4.3 + or - 0.5 decreased immediately to zero, but corresponding COD removal rates remained in the same order of magnitude as with full aeration. Only with pe sub 7 < or = 0 (pH 7) did COD removal rates decline to 'anoxic' levels. pH was also feedback controlled. At pH = 6.0 + or - 0.2, COD removal rate was much lower corresponding to the CO2 accumulation at this pH. The economic advantage of O2 regulation becomes apparent when DO versus pe feedback control are compared. With the typical minimum DO feedback control condition of = 1 ppm, there would be a 0.07 kp per cu m per hr loss in oxygen feed. Control of the oxic self-purifying activity by pe feedback can be done at zero DO concentration, leading to maximal velocities of oxygen supply to DO-consuming microorganisms. (Rochester-IVI)
W86-00945

MERCURY IN SEDIMENT IN SWEDISH FOREST LAKES,
National Swedish Environment Protection Board, Solna.
K. Johansson.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2359-2363, 1985. 2 Fig, 19 Ref.

Descriptors: *Mercury, *Lake sediments, *Sweden, *Heavy metals, Metals, Water pollution, Sediments, Spatial distribution, Stratigraphy, Hydrogen ion concentration, Source of pollutants, Organic matter, Water depth.

Mercury content of Swedish lake sediments has apparently increased, mainly during the 20th century; in southern and central Sweden mercury content increases in the uppermost sediments are about 200 micro-g/kg of dry sediment (DS), whereas in the northernmost part of the country the increase is only about 20 micro-g/kg DS. Mercury contents of surface sediments were studied in 106 lakes, and the vertical distribution of mercury in sediments was studied in 14 lakes. In sediments from lakes in the southwestern area, near the coast, mercury content in sediments was correlated with three factors: organic matter content ($r=0.37$), pH of the water ($r=-0.40$), and water depth ($r=0.34$) (all $p < 0.01$). In the central part of the country, sediment mercury co-varied strongly with organic matter ($r=0.73$, $p < 0.001$); when factors regulating the mercury content in the sediment at each area are accounted for, no major differences in mercury levels in the sediments from these two areas are seen. Two areas in the north-central part of the country had much lower mercury contents; the mercury content of sediments decreased from north to south ($r=-0.38$, $p < 0.05$), with water depth and pH factors being of secondary importance. The increase in mercury in sediments of Swedish lakes during the 20th century almost certainly has anthropogenic causes; in Sweden probably about 40,000 lakes larger than 0.01 sq km are affected by these elevated mercury levels. (Rochester-IVI)
W86-00952

CADMIUM AND CHROMIUM IN THE WATERS, SEDIMENTS AND BIOTA OF THE VAL PARMA RUNNING WATER ECOSYSTEM,
Parma Univ. (Italy). Ist. di Ecologia.
G. Gorbi, and G. Campanini.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2385-2389, 1985. 1 Fig, 2 Tab, 12 Ref.

Descriptors: *Val Parma, *Torrente Parma, *Po River, *Italy, *Cadmium, *Chromium, *Sediments, *Bioaccumulation, Macroinvertebrates, Algae, Heavy metals, Metals, Water pollution effects, Fate of pollutants.

The bulk of Cd and Cr in the Val Parma (Torrente Parma, tributary of the Po River, Italy) drainage basin was found in the sediments; water sediment, benthic macroinvertebrates, and algae were sampled. Stations were Lago Santo (1) and Bosco (2), which receive unpolluted mountain runoff, Cinghio (3), which collects hill and some agricultural runoff, Galasso (4), which receives water from agricultural areas with some industrial activity, Naviglio Navigabile (5), which receives urban and industrial wastes, and Colorno (6), which is downstream from all the others, and receives the runoff from the entire Val Parma. Levels of Cd in water were not significantly different from station to station, but for Cr the stations could be grouped: 1, 2, 3 < 4, 5, 6. The Tukey test permitted separation of bottom sediments based on Cd as 1, 2, 3, 4 < 5, 6, and for Cr as 1, 2, 3 < 4, 6 < 5. In macroinvertebrates, the pattern for Cd showed that only Lago Santo organisms had significantly different levels, as follows: 1 > 2, 3, 4, 5, 6. No significant differences could be found for Cr in macroinvertebrates. In algae, Cd showed no pattern of significant variations in content, but Cr exhibited the pattern 1, 2, 3 < 6 (no data for 4, 5). The results confirm that the bulk of cadmium and chromium in this ecosystem occurs in the sediments. Water is strictly correlated with sediments only for chromium. (Rochester-IVI)
W86-00957

SEDIMENT AS A RECORD OF COPPER POLLUTION IN LAKE ORTA,
Istituto di Ricerca sulle Acque, Milan (Italy). Reparto Sperimentale di Idrobiologia Applicata.
A. Provini, and G. F. Gaggino.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2390-2393, 1985. 3 Fig, 12 Ref.

Descriptors: *Lake sediments, *Lake Orta, *Italy, *Copper, *Fate of pollutants, Rayon industry, Industrial wastewater, Sediments, Chromium, Zinc, Stratigraphy, Sedimentology.

Analysis of sedimentary Cu in Lake Orta, a subalpine lake in northern Italy which has been receiving discharges of a cuproammonia rayon factory since 1927, shows that the present rate of Cu deposition in the sediments is 4 ton/yr, with a concentration in the water at circulation of about 40 mg/cu m. The metal content of sediments deposited in the lake since 1927, excluding the natural background of 1 ton/yr, is estimated to be 560 tons for Cu, 380 tons for Cr, and 30 tons for Zn. Surficial (0-3 cm) sediments contain 1-4 mg/g dry weight Cu, 1-2.7 mg/g Cr, and 0.3-1.5 mg/g Zn; maximum values were always found in the basin nearest the rayon factory, with a general decreasing trend along the longtudinal axis of the lake toward the outlet. Radiocesium dating of the sediments made it possible to show good agreement between changes in Cu content of the lake sediments over time and the limited information available on loading by the rayon factory. From the pollution history in the sediments and other information on copper mobility in sediments, it is apparent that, at the present low pH, the lake sediments do not contribute to the copper pollution, in spite of their copper content. Only a drastic reduction of copper and ammonia in the wastewater discharges can lower the Cu concentration to acceptable levels. (Rochester-IVI)
W86-00958

EFFECTS OF 2,4-D ON NATURAL PHYTOPLANKTON SYSTEMS IN ASSOCIATION WITH MYRIOPHYLLUM SPICATUM,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5C.
W86-00965

RADIONUCLIDE CONTENT MEASUREMENT AND INTERPRETATION IN FISH FROM THE UPPER RHONE RIVER IN FRANCE (MESURE ET INTERPRETATION DES TENEURS EN RADIONUCLEIDES DE POISSONS DU HAUT-RHONE FRANCAIS),
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France). Service d'Etudes et Recherches sur l'Environnement.
For primary bibliographic entry see Field 5A.
W86-00970

DIBUTYLPHTHALATE DEGRADATION IN ESTUARINE AND FRESHWATER SITES,
Gulf Coast Research Lab., Ocean Springs, MS.
W. W. Walker, C. R. Cripe, P. H. Pritchard, and A. W. Bourquin.
Chemosphere, Vol. 13, No. 12, p 1283-1294, 1984. 4 Fig, 4 Tab, 15 Ref.

Descriptors: *Dibutylphthalate, *Biodegradation, *Estuarine environment, Sediments, Microbial degradation, Adaptation, Industrial chemicals, Phthalic acid esters.

The phthalic acid ester di-n-butylphthalate (DBP) appears to be readily biodegradable in estuarine as well as freshwater environments. Biotic and abiotic degradation DBP in water and sediment/water systems from six different estuarine and freshwater sites in Louisiana, Mississippi and Florida was investigated under laboratory conditions. DBP disappearance was rapid in all microbially active systems and substantially reduced under sterile conditions. Adaptation of microbial populations to degrade DBP was indicated in six of nine evaluations conducted. The presence of sediment significantly increased biodegradation rates in five of the six sites. Even though DBP would not be considered a persistent chemical, its degradation is controlled by a variety of unknown factors which are not consistent from site to site or from one sampling date to another. Microbial communities from some sites showed adaptation, while others commenced degradation without lag. Some sites showed sediment enhance degradation and others did not, and some sites reflected rapid exponential dieaways while others showed slow linear dieaways. (Moore-IVI)
W86-00994

ASSESSMENT OF THE SIGNIFICANT PHYSICOCHEMICAL INTERACTIONS INVOLVED IN PESTICIDE DIFFUSION WITHIN A PESTICIDE-SEDIMENT-WATER SYSTEM,
Agricultural Research Service, Riverside, CA. Salinity Lab.
D. L. Corwin, and W. J. Farmer.
Chemosphere, Vol. 13, No. 12, p 1295-1317, 1984. 12 Fig, 1 Tab, 22 Ref. Water Resources Center project UCAL-WRC-W-485.

Descriptors: *Pesticides, *Diffusion, *Mathematical models, Sediment-water interfaces, Porous media, Adsorption, Hysteresis, Fate of pollutants, Physicochemical properties.

Because of the ability of soil to adsorb a variety of chemicals and the subsequent transport of the chemicals via erosion processes into aquatic systems, sediments of various water bodies have become repositories for many harmful chemicals. Using the explicit method of finite differences, a one-dimensional numerical model for the diffusion of pesticides through a sorbing porous medium under saturated conditions has been developed to assess the significant physical and chemical properties which influence the diffusion process in an aquatic system. Models were developed for the three different types of adsorption generally encountered in a sorbing porous medium: linear, Freundlich and Langmuir. An additional model deals with hysteresis for the three adsorption situations. The models show that the degree to which a pesticide is retained by a sediment is determined by the sediment's adsorptive capacity, strength of adsorption, porosity and bulkdensity, as well as the temperature of the aquatic system, the chemical nature of the pesticide and the pesticide's aqueous solution diffusion coefficient. The pollution of overlying water bodies by the diffusion of pesticides from sediments is a potential problem due to the toxic effect of very low levels of some pesticides to aquatic life forms. A sediment with a high adsorptive capacity and a high strength of adsorption would release pesticides to the water at a slower rate and in lower amounts, posing less of a potential hazard to fish. Highly organic sediments which could retain high levels of adsorbed pesticide material could pose a threat to filter-feeding organisms which rely upon organic matter at the sediment-water interface as a food source. (Moore-IVI)
W86-00995

MODULAR CONTAINERS FOR MICROCOSM AND PROCESS MODEL STUDIES ON THE FATE AND EFFECTS OF AQUATIC CONTAMINANTS,
Columbia National Fisheries Research Lab., MO.
J. N. Huckins, J. D. Petty, and M. A. Heitkamp.
Chemosphere, Vol. 13, No. 12, p 1329-1341, 1984. 3 Fig, 1 Tab, 15 Ref.

Descriptors: *Microcosms, *Fate of pollutants, *Model studies, Ecosystems, Lentic environments, Simulation, Microbial degradation, Fonofos, Trifluralin, Carbon radioisotopes, Mass balance.

Container modules are described for the laboratory simulation of selected processes and ecosystems that are representative of lentic environments. Emphasis is placed on design features permitting mass balance accountability of contaminant residues and procedural cautions required for the proper use of the described systems in environmental simulations. Experiments on the efficiency of container modules for microbial mineralization studies were conducted using C-14 labeled NaHCO3, and acidification resulted in a C-14-CO2 recovery of 97.3 +/- 4.7%. The trapping efficiency of pesticides volatilized from water and glass surfaces was investigated using the same module and the mean recoveries of C-14-fonofos and C-14-trifluralin were 114.2 +/- 3.2% and 95.2 +/- 3.5%, respectively. The mass balance capabilities of the system was also demonstrated for extended microcosm exposures to C-14-trifluralin. (Author's abstract)
W86-00996

LEACHABILITY OF CARBON-14-LABELLED 3,4-BENZOPYRENE FROM COAL ASH INTO AQUEOUS SYSTEMS,
Hoofdgroep Maatschappelijke Technologie TNO, Delft (Netherlands).
A. C. Besemer, and J. Kanij.
Chemosphere, Vol. 13, No. 12, p 1343-1351, 1984. 5 Tab, 18 Ref.

Descriptors: *Benzopyrene, *Leaching, *Coal ash, Polycyclic aromatic hydrocarbons, Carbon radioisotopes, Tracers, Hydrocarbons, Aromatic compounds, Water pollution sources.

Combustion products such as fly ash from coal-fired furnace and municipal incinerators may contain harmful substance, such as polycyclic aromatic hydrocarbons (PAH). In contact with aqueous systems, leaching of these substances can lead to contamination of the environment. The leachability of polycyclic aromatic hydrocarbons from coal ash into aqueous systems was studied. Carbon-14-labeled 3,4-benzopyrene (BaP) was deposited on coal fly ash at about 10 micro-g/g ash. The desorption of BaP was measured using aqueous solutions of acetone and methanol as extractants and liquid scintillation counting as detection method. In all cases the C-14 recovery was incomplete. Using water as extractant, C-14 recoveries of about 1% were found. In the presence of a non-ionic surface active agent the C-14 recovery was enhanced significantly. In order to assess the potential hazard of disposed fly ash with respect to the leaching of toxic substances it is necessary to develop testing methods with real representative adsorbents under realistic aqueous waste disposal conditions. (Moore-IVI)
W86-00997

FATE AND EFFECTS OF PENTACHLOROPHENOL IN HARD- AND SOFT-WATER MICROCOSMS,
Environmental Research Lab., Athens, GA.
D. L. Brockway, P. D. Smith, and F. E. Stancil.
Chemosphere, Vol. 13, No. 12, p 1363-1377, 1984. 2 Fig, 3 Tab, 16 Ref.

Descriptors: *Pentachlorophenol, *Microcosms, *Fate of pollutants, *Water pollution effects, Hardness, Nutrients, Silica, Oxygen, Chlorophenols.

Microcosms were used to investigate the influence of water hardness on the fate and effects of pentachlorophenol (PCP). The laboratory ecosystems developed similarly in both hard and soft water with only minor differences in structure and function. After exposure to PCP, system structure showed minor evidence of impact, but the results were similar in both hard and soft water. Dissolved silica was the only nutrient that responded differently in hard and soft water. It was the only nutrient significantly influenced by PCP, and may be a sensitive parameter for detecting low level effects of toxicants in certain systems. Differences between hard and soft water were detected in net oxygen production when the systems were exposed to 4 mg/l PCP. (Moore-IVI)
W86-00998

MATHEMATICAL SIMULATION OF THE CONVERSION AND TRANSPORT OF NUTRIENTS IN DRAINAGE AREAS - A REVIEW OF THE LITERATURE (MATHEMATISCHE SIMULATION VON NAHRSTOFFUMWANDLUNG UND -TRANSPORT IN EINZUGSGEBIETEN-LITERATURUBERSICHT),
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographie und Geooekologie.
V. Mohaupt, and G. Wernecke.
Acta Hydrochimica et Hydrobiologica, Vol. 11,

No. 6, p 609-621, 1983. 65 Ref.

Descriptors: *Mathematical models, *Simulation, *Nutrients, *Reviews, Nitrogen, Phosphorus, Solute transport, Runoff, Infiltration, Sediment erosion, Adsorption, Desorption.

Models used for mathematical description of nitrogen and phosphorus transport are outlined for various components of runoff; transport of nutrients in the process of runoff formation and concentration, infiltration and runoff within soil, surface runoff, and transport in receiving water. For surface runoff the Universal Soil Loss Equation is used frequently as the starting point for modeling, as well as for calculating sediment impulse loads. Adsorption and desorption are taken into account by their respective isotherms. Models from agriculture are used for representing soil nutrient balance, whereas for transport in receiving water, regressions on flow and deterministic models of nutrient conversion are applied. In all models the empirical share is still very high, and the model checking has often failed due to insufficient measured data. (Author's abstract)
W86-00999

ELIMINATION OF NUTRIENTS IN THE ROZKOS-RESERVOIR,
Prague Dept. of Water Technology and Environmental Engineering (Czechoslovakia).
J. Maixner, and V. Sladecek.
Acta Hydrochimica et Hydrobiologica, Vol. 11, No. 6, p 657-665, 1983. 3 Fig, 5 Tab, 17 Ref.

Descriptors: *Nutrients, *Rozkos Reservoir, *Czechoslovakia, Reservoirs, Fate of pollutants, Organic compounds, Nitrogen, Phosphorus, Iron, Bacteria.

The reservoir, having a volume of 76 cu hm, a surface area of 1001 ha and a maximum depth of 17 m, is divided by a dam into two parts. Half of the upper part with an area of 200 ha is densely covered by macrophytes (Elodea, Potamogeton). The three main tributaries with 2.6 cu m/s on an average are highly polluted and show alpha-meso-saprobic conditions. The reservoir is investigated between September and March in its longitudinal section at eight stations. The organic load and the total solids show a total decrease by 60% and 66%, respectively, and 70% of the selfpurification occurs in the upper, separated part of the reservoir. In the same way, also the total nitrogen is reduced, whereas the total phosphorus is reduced already in the upper part of the reservoir by 71%, then decreasing to 21% in the second part of the reservoir. With phosphorus, in addition to the biological elimination, precipitation by the dissolved iron also occurs; the iron concentration is reduced by 44 or 76%, respectively. The bacteriological load of water improved by two to three orders of magnitude. (Author's abstract)
W86-01002

ENVIRONMENTAL BEHAVIOR OF FLUOROTENSIDES. PART 2. INVESTIGATION ON THE BIOCHEMICAL DEGRADABILITY (ZUM UMWELTVERHALTEN VON FLUORTENSIDEN. TEIL 2. UNTERSUCHUNG DER BIOCHEMISCHEN ABBAUBARKIET),
Akademie der Wissenschaften der DDR, Berlin. Zentralinstitut fuer Organische Chemie.
D. Prescher, U. Gross, J. Wotzka, M. Tscheu-Schluter, and W. Starke.
Acta Hydrochimica and Hydrobiologica, Vol. 13, No. 1, p 17-24, 1985. 2 Fig, 5 Tab, 7 Ref.

Descriptors: *Degradation, *Fluorotensides, *Surfactants, Tensides, Fate of pollutants, Biochemical degradation, Surfactants, Detergents.

In continuation of a publication on the behavior of fluorotensides in aqueous solution there were tested four selected fluorotensides, among them a nonionic ethoxylated substance and three anionactive substances, in two different types of equipment with respect to their biochemical degradability. The BOD5, the potassium permanganate consumption, the dry matter contents and the loss on ignition as well as the dehydrogenase test were used as parameters for judging the degradation behavior. In all the four cases a high biochemical stability was found, so that they must be classified into the group C 'biochemically not degradable or difficult to degrade' in agreement with the results found, according to the water pollutants catalogue. (Author's abstract)
W86-01007

HUMIC ACIDS IN THE INFLOWS TO THE FLAJE RESERVOIR AFTER DEFORESTATION OF ITS WATERSHED,
Vyzkumny Ustav Vodohspodarsky, Prague (Czechoslovakia).
For primary bibliographic entry see Field 6G.
W86-01010

CONTRIBUTION TO THE ANALYTICAL DESCRIPTION OF TRANSPORT PROCESSES IN THE AQUIFER AT A DIFFUSE SUBSTANCE INPUT (BEITRAG ZUR ANALYTISCHEN BESCHREIBUNG VON TRANSPORTPROZESSEN IM GRUNDWASSERLEITER BEI DIFFUSEM STOFFEINTRAG),
Institut fuer Wasserwirtschaft, Berlin (German D.R.).
M. Schwan.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 59-66, 1985. 1 Fig, 8 Ref.

Descriptors: *Mathematical models, *Aquifers, *Water quality, Differential equations, Solute transport, Model studies, Free water, Groundwater movement, Dispersion, Path of pollutants.

A model is described for the relation between water quantity and water quality in the aquifer with the diffuse substance input by the gravitation water being taken into account. The model is based on a partial differential equation of the second order for a flow pipe. For constant transport parameters, a sink of the kinetics of the first order and a time-dependent source term an exact analytical solution is presented and explained by a model. At a diffuse substance input, the dispersion has only a slight influence on the transport of substances contained in water. Potential applications of these solutions to different problems are mentioned. (Author's abstract)
W86-01012

GROUNDWATER POLLUTION HAZARD IN THE CAPE FLATS,
National Inst. for Water Research, Bellville (South Africa). Cape Regional Lab.
For primary bibliographic entry see Field 5G.
W86-01017

ESTIMATION OF THE LOADS OF SOME LIST I AND II SUBSTANCES TO UNITED KINGDOM TIDAL WATERS - A COMPARISON WITH PREVIOUS ESTIMATES,
Water Research Centre, Stevenage (England).
For primary bibliographic entry see Field 5G.
W86-01025

ESTIMATED STORE OF SOLUBLE SALTS IN THE LAKE EYRE CATCHMENT IN QUEENSLAND AND THEIR POSSIBLE TRANSPORT IN STREAMFLOW TO THE LAKE,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
For primary bibliographic entry see Field 2A.
W86-01031

MOVEMENT OF SEPTIC TANK EFFLUENT THROUGH SANDY SOILS NEAR PERTH. I. MOVEMENT OF NITROGEN,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Animal Production.
B. R. Whelan, and N. J. Barrow.
Australian Journal of Soil Research, Vol. 22, No. 3, p 283-292, 1984. 6 Fig, 4 Tab, 23 Ref.

Descriptors: *Septic tanks, *Effluents, *Nitrogen, Path of pollutants, Ammonium, Nitrates, Hydrogen ion concentration, Wastewater treatment, Soak wells, Leach drains, Groundwater pollution, Perth, Australia.

The movement and transformation of nitrogen under seven septic tank installations was studied. Samples of the effluent and of the soil solution beneath the discharge systems were taken and analyzed for ammonium, nitrate and pH. Most of the nitrogen came from household toilets, and after passage through a septic tank, the nitrogen was mostly in the ammonium form. It remained in this form while it was in the ponded effluent above the slime layer in the absorption systems. Once it had passed through the slime layer into the unsaturated, aerobic soil below, it was usually oxidized to nitrate within 0.5 m. This was accompanied by a drop in pH of about two units. However, in one case in which the distance between the top of the slime layer and the water table was less than 0.8 m, ammonium was not oxidized to nitrate. This was taken to indicate that the saturated zone extending below the absorption system overlapped the capillary fringe and consequently the soil was anaerobic. Accumulation of organic nitrogen was restricted to the 0.5 m slime layer which accumulated on the sandy base of the soak wells and leach drains. The low cation exchange capacity of the soil and the high rate of conversion of ammonium in the effluent to nitrate in the unsaturated soil resulted in almost all of the nitrogen from the septic tanks entering the groundwater except that lost to plant uptake. (Author's abstract)
W86-01034

MOVEMENT OF SEPTIC TANK EFFLUENT THROUGH SANDY SOILS NEAR PERTH. II. MOVEMENT OF PHOSPHORUS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Animal Production.
B. R. Whelan, and N. J. Barrow.
Australian Journal of Soil Research, Vol. 22, No. 3, p 293-302, 1984. 6 Fig, 3 Tab, 17 Ref.

Descriptors: *Septic tanks, *Effluent, *Phosphorus, Path of pollutants, Wastewater treatment, Groundwater pollution, Soak wells, Leach drains, Sorption, Soils, Domestic wastes, Perth, Australia.

The potential of seven septic tank installations in the Perth (Western Australia) metropolitan area to contribute phosphate to the groundwater was investigated. The phosphate concentration in the soil solution below the soak wells and leach drains was measured using immiscible displacement and compared with the phosphate concentration of the water flowing into the systems. The phosphate sorbing properties of the subsoils were measured, and these were found to vary up to 100-fold within the same profile. A very strong correlation was established between a laboratory measure of the ability of the soil to sorb phosphate and the phosphate sorbed in the soil profile below leach drains and soak wells. The correlation held only for those systems for which little further phosphate was removed by reaction with the soil, and the phosphate in the soil solution was at or near the same concentration as the phosphate in the effluent. For a system receiving water from the bathroom, laundry and kitchen the phosphate concentration was as low as 8 micro-g P/mol. For a system receiving water from a toilet only, the concentration was as high as 29 micro-g P/ml. In systems receiving water from both sources the values were intermediate. For systems that had been installed for more than a few years, the concentration of phosphorus in the soil water down to 6 m below the soak well and leach drain was similar to that in the effluent being discharged into the soil. (Author's abstract)
W86-01035

STREAM DISSOLVED OXYGEN ANALYSIS AND CONTROL,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
D. A. Todd, and P. B. Bedient.
Journal of Environmental Engineering, Vol. 111, No. 3, p 336-352, June, 1985. 11 fig, 1 Tab, 25 Ref.

Descriptors: *Dissolved oxygen, *Water pollution sources, *Water quality control, *Buffalo Bayou,

*Texas, Wastewater pollution, Water pollution control, Wastewater treatment, Low flow, Temperature effects, Streams, Computer models, Aeration, Flow augmentation.

The Buffalo Bayou study segment is 22.5 mi in length and drains 270 sq mi of western Houston, Texas, receiving the effluent from 43 waste treatment plants. The stream is heavily stressed by domestic waste loads and has shown significant degradation in water quality since 1970. Current data indicate that the stream reaches critical water quality levels for significant lengths of the stream for extended periods during the low flow/high temperature months of June, July, and August. The location of critical stream dissolved oxygen (DO) measurements suggests that the high headwater BOD levels, and many upstream package plants are at least partly responsible for the water quality problems. A computer model was calibrated, verified, and applied to simulate worst case conditions and to test a series of stream protection alternatives. A combined program of sewage plant regionalization, stream aeration, and flow augmentation was found to be the most cost-effective solution. Institutional changes will be necessary to enable the technical improvements to be made. The upper reach of the Bayou must be designated as a water quality limited stream segment. This would enable stream standards to be set and enforced by means of a waste load allocation. Regionalization and stream aeration would require special financing and legal status. Flow augmentation would depend on receiving redesignation of the Addicks and Barker Flood control reservoirs as suitable for storage for water quality applications. (Moore-IVI)
W86-01043

ERRORS FROM USING CONSERVATION OF BUOYANCY CONCEPT IN PLUME COMPUTATIONS,
Engineering Analysis, Inc., Huntsville, AL.
F. B. Tatom.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 1005-1009, June, 1985. 1 Fig, 2 Tab, 8 Ref.

Descriptors: *Plumes, *Path of pollutants, *Buoyancy, Heated water, Thermal pollution, Jets.

The concept of conservation of buoyancy was introduced for the analysis of buoyant gas plumes in the atmosphere. This conservation principle is actually an approximate form of the conservation of energy equation, but for gases at atmospheric pressure it is quite sufficient. For buoyant thermal jets and plumes in water, the use of the conservation of buoyancy principle should be avoided wherever possible, especially for cases involving low water temperatures. Any plumes predicted by models based on such an approach will tend to overestimate the effect of buoyancy and this tendency should be taken into account in applying the results from such models. Of more fundamental importance is the fact that the conservation of buoyancy is not a basic conservation principle analogous to conservation of mass, momentum, and energy. Instead, it is an approximation which must be applied with caution, especially in fluids with variable thermal coefficients of volumetric expansion. (Baker-IVI)
W86-01051

TURBULENT DISPERSION FROM A STEADY TWO-DIMENSIONAL HORIZONTAL SOURCE,
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
R. I. Nokes, A. J. McNulty, and I. R. Wood.
Journal of Fluid Mechanics, Vol. 149, p 147-159, December, 1984. 7 Fig, 2 Tab, 10 Ref.

Descriptors: *Dispersion, *Turbulence, *Path of pollutants, Mathematical equations, Fluid mechanics, Velocity, Diffusivity.

The two-dimensional steady-state turbulent-diffusion equation is solved by a separation-of-variables process that leads to a Sturm-Liouville eigenvalue problem. The general solution, for arbitrary velocity and diffusivity distributions, is shown to be in the form of an eigenfunction expansion. For a steady uniform flow in a wide, open channel the velocity distribution in the vertical is well approximated by a logarithmic lay and the diffusivity distribution is approximately parabolic. For these distributions the power-series solution technique for ordinary differential equations is used to determine the eigenfunctions and eigenvalues. The solution is compared with the standard solution that Holley, Siemans and Abraham (1972, J. Hydraul. Res. 10, 27-57) obtained for a uniform velocity and diffusivity distribution. Experimental results are presented, and these show that (1) the use of the correct velocity and diffusivity distribution results in a significant improvement in the agreement between experiment and theory; and (2) close to the source the fluctuations of concentration are of the order of the mean values. (Author's abstract)
W86-01055

WHEN AND WHERE TO PUT A DISCHARGE IN AN OSCILLATORY FLOW,
Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
R. Smith.
Journal of Fluid Mechanics, Vol. 153, p 479-499, April, 1985. 7 Fig, 13 Ref, 1 Append.

Descriptors: *Path of pollutants, *Oscillatory flow, *Mathematical equations, Flow, Discharge, Mathematical models, Dispersion, Estuaries.

Exact results are obtained for the centroid and longitudinal variance of a passive contaminant distribution at large times after an instantaneous discharge in an oscillatory flow in a straight channel of constant cross section. The precise timing and cross stream position of the discharge have a substantial and persistent influence. When and where to put a discharge in an oscillatory flow so that the spread of contaminant at large times is maximized (and the concentration is minimized) is considered. In an oscillatory flow the optimal location for a discharge will be away from the center or the sides. When the flow is oscillatory the contaminant is swept back and forth along the channel, so any time advantage is annulled. An important practical point is that real discharges are not passive. Near field momentum and buoyancy effects tend to augment the transverse mixing. The actual contaminant cloud well be wider than a passive cloud, and the effective time of discharge is earlier than the actual discharge time. The general principles are illustrated using a simple mathematical model of contaminant dispersion in a vertically well-mixed estuary of parabolic cross-section. (Baker-IVI)
W86-01056

RATE OF PRECIPITATION OF FERROUS IRON AND FORMATION OF MIXED IRON-CALCIUM CARBONATES BY NATURALLY OCCURRING CARBONATE MATERIALS,
Western Australian Inst. of Tech., South Bentley. School of Applied Chemistry.
J. E. Wajon, G.-E. Ho, and P. J. Murphy.
Water Research, Vol. 19, No. 7, p 831-837, 1985. 3 Fig, 4 Tab, 22 Ref.

Descriptors: *Fate of pollutants, *Iron, *Carbonates, *Chemical precipitation, Limestone, Calcite, Aragonite, Siderite, Supersaturation, Industrial wastewater, Wastewater pollution, Land disposal, Groundwater pollution.

An acidic iron-rich effluent produced by an industry in the southwest of Western Australia is disposed of by seepage through carbonate-rich sand dunes. The soluble iron content of the effluent was reduced from 6 g/l to less than 60 mg/l within several hundred meters of the disposal area. In order to determine what occurs under these conditions, an iron sulfate containing wastewater was reacted with aragonite, calcite and a variety of limestones and limesands pH values near 6 in an atmosphere of carbon dioxide. Siderite (ferrous carbonate) and a calcium siderite containing 10 mol% calcium were the only iron-containing products detected by X-ray diffraction, and accounted for substantially all the iron removed from solution. Calcium siderite was the major product and constituted between 50 and 100% of the iron containing product. The rate of precipitation of iron was proportional to the square of the supersaturation of the solution with respect to siderite, and increased with increase in pH and alkalinity. Precipitation occurred at different rates with different carbonate materials, tending to increase with increasing proportion of aragonite in the material. Precipitation did not occur in suspensions of calcite and was slow even in suspensions of aragonite where equilibrium was not reached within 40 days. The frequent occurrence of groundwaters apparently supersaturated with respect to siderite may be due either to slow precipitation of siderite, or to equilibrium of the groundwater with respect to a more soluble calcium siderite. The minerals present in an aquifer should be identified before conclusions on the saturation state of a groundwater with respect to siderite are made. (Moore-IVI)
W86-01058

VALIDITY OF THE LOCAL EQUILIBRIUM ASSUMPTION FOR MODELING SORBING SOLUTE TRANSPORT THROUGH HOMOGENEOUS SOILS,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
A. J. Valocchi.
Water Resources Research, Vol. 21, No. 6, p 808-820, June, 1985. 6 Fig, 2 Tab, 54 Ref, 2 Append.
NSF grant CEE-8204434.

Descriptors: *Fate of pollutants, *Model studies, *Solute transport, Sorption, Soils, Mathematical models, Porous media, Chemical equilibrium.

Sorption processes that occur during reactive solute movement through porous media can be modeled using either an equilibrium or kinetic approach. Because of the resulting conceptual and mathematical simplification, many transport models assume local chemical equilibrium is valid for describing sorption reactions. This paper presents quantitative criteria to assess the validity of the local equilibium assumption for one-dimensional, steady flow through homogeneous soils. A method is described whereby formulas for solute breakthrough curve time moments can be determined without knowledge of the analytical solution to the mass transport model. This method is applied to several commonly used nonequilibrium formulations as well as the standard linear equilibrium model. The formulations considered include both the physical nonequilibrium models where the sorption rate is controlled by diffusive solute transfer between mobile and stagnant fluid zones and the chemical nonequilibrium models where the overall sorption rate is governed by the rate of reaction at the soil-solution interfaces. Criteria for local equilibrium to be valid are derived by comparing the time moment formulas for the nonequilibrium and equilibrium models. These criteria explicitly show that basic system parameters (e.g., seepage velocity, dispersion coefficient, distribution coefficient, sorption rate, boundary conditions) have a significant influence on the attainment of local equilibrium. (Author's abstract)
W86-01072

GROUND-WATER CONTAMINATION IN SILICON VALLEY,
California Regional Water Quality Control Board, Oakland. San Francisco Bay Region.
A. Olivieri, D. Eisenberg, M. Kurtovich, and L. Pettegrew.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 346-358, July, 1985. 7 Fig, 2 Tab, 6 Ref.

Descriptors: *San Francisco Bay Area, *California, *Groundwater pollution, Water pollution sources, Soil contamination, Solvents, Underground tanks, Corrosive substances, Fuel, Wastewater, Regulations.

In the southern San Francisco Bay Area (California), a state regulatory agency carried out a questionnaire survey to determine the locations and characteristics of underground chemical storage and handling facilities at industrial sites in the area. Sampling of soil and ground water were required at sites where underground tanks containing sol-

vents were reported. The survey identified 1,692 tanks at 388 sites. The largest fraction were pretreatment sumps for industrial wastewater, followed by fuel tanks, solvent tanks, and tanks containing corrosives. Solvent tanks were reported at 96 sites. Subsurface investigations resulted in discovery of soil or ground water contamination (or both) at 75 of the 96 sites with solvent tanks. Further investigations and remedial actions are underway at these sites, and new regulations have been adopted at the state and local levels to prevent future release of industrial chemicals into soil and ground water. (Author's abstract)
W86-01108

ARSENIC, BARIUM, GERMANIUM, TIN, DIMETHYLSULFIDE AND NUTRIENT BIOGEOCHEMISTRY IN CHARLOTTE HARBOR, FLORIDA, A PHOSPHORUS-ENRICHED ESTUARY,

Florida State Univ., Tallahassee. Dept. of Oceanography.
P. N. Froelich, L. W. Kaul, J. T. Byrd, M. O. Andreae, and K. K. Roe.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 3, p 239-264, March, 1985. 6 Fig, 5 Tab, 75 Ref.

Descriptors: *Arsenic, *Barium, *Germanium, *Tin, *Dimethylsulfide, *Nutrients, *Biogeochemistry, *Charlotte Harbor, *Florida, Peace River, Estuaries, Salinity, Phosphates, Nitrates, Silica, Water pollution sources, Eutrophication, Diatoms, Fate of pollutants.

Concentrations of dissolved nutrients (NO3, PO4, Si), germanium species, arsenic species, tin, barium, dimethylsulfide and related parameters were measured along the salinity gradient in Charlotte Harbor (Florida). Phosphate enrichment from the phosphate industry on the Peace River promotes a productive diatom bloom near the river mouth where NO3 and Si are completely consumed. Inorganic germanium is completely depleted in this bloom by uptake into biogenic opal. The Ge/Si ratio taken up by by diatoms is about 0.0000007, the same as that provided by the river flux, confirming that silceous organisms incorporate germanium as an accidental trace replacement for silica. Monomethylgermanium and dimethylgermanium concentrations are undetectable in the Peace River, and increase linearly with increasing salinity to the seawater end of the bay, suggesting that these organogermanium species behave conservatively in estuaries, and are neither produced nor consumed during estuarine biogenic opal formation or dissolution. Inorganic arsenic displays slight removal in the bloom. Monomethylarsenic is produced both in the bloom and in mid-estuary, while dimethylarsenic is conservative in the bloom but produced in mid-estuary. The total production of methylarsenicals within the bay approximately balances the removal of inorganic arsenic, suggesting that most biological arsenic uptake in the estuary is biomethylated and released to the water column. Dimethylsulfide (DMS) increases with increasing salinity in the estuary and shows evidence of removal, probably both by degassing and be microbial consumption. An input of DMS is observed in the central estuary. The behavior of total dissolvable tin shows no biological activity in the bloom or in mid-estuary, but does display a low-salinity input signal that parellels dissolved organic material, perhaps suggesting an association between tin and dissolved organic matter. Barium displays dramatic input behavior at mid-salinities, probably due to slow release from clays deposited in the harbor after catastrophic phosphate slime spills into the Peace River. (Author's abstract)
W86-01113

SEA-SURFACE MICROLAYER METALS ENRICHMENTS IN AN URBAN AND RURAL BAY,

Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
J. T. Hardy, C. W. Apts, E. A. Crecelius, and N. S. Bloom.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 3, p 299-312, March, 1985. 7 Fig, 1 Tab, 48 Ref. DOE DE-AC06-76RLO 1830.

Descriptors: *Microlayers, *Metals, *Water pollution sources, *Bays, Urban areas, Lead, Zinc, Copper, Cadmium, Iron, Atmospheric deposition, Coastal waters, Marine environment.

The sea-surface microlayer is an important interface between the atmosphere and ocean and a collection point for many anthropogenic materials including potentially toxic metals. A glass plate sampler sampler was developed to collect the upper 30 to 55 micrometers of the sea surface. Samples of the microlayer and subsurface bulk water from an urban and rural bay were analyzed for concentrations of Pb, Zn, Cu, Cd, and Fe. Metal concentrations in both the microlayer and bulk water were generally 2 to 15 times greater in the urban than in the rural bay. Concentrations of metals in the microlayer of both bays averaged 6 to 65 times greater than those in the bulk water. In the urban bay, microlayer concentrations of Pb, Zn and Cu from 10 to > 100 micro-g/l were common. Measured microlayer metals concentrations agree well with those predicted from atmospheric deposition rates using a previously derived empirical model developed from laboratory microcosm studies. Further work will be required to determine whether or not these high microlayer metal concentrations contain significant biologically available fractions which could impact fisheries recruitment of larval icthyoneuston. (Author's abstract)
W86-01114

FLUXES AND RESIDENCE TIMES OF HYDROCARBONS IN THE COASTAL MEDITERRANEAN: HOW IMPORTANT ARE THE BIOTA,

International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
K. A. Burns, J.-P. Villeneuve, and S. W. Fowler.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 3, p 313-330, March, 1985. 3 Fig, 6 Tab, 46 Ref. NSF grant OCE 7923321.

Descriptors: *Hydrocarbons, *Fate of pollutants, *Mediterranean Sea, *Biota, Particulate matter, Chlorinated hydrocarbons, Petroleum products, Zooplankton, Primary productivity, Microlayers, Solute transport, Sediments, Marine environment.

Settling particles collected in semi-permanent particle interceptor traps (PITs) moored at 100 m depth in a water column of 250 m at a distance of 2 km from the Monaco coast in the north western Mediterranean were analyzed for petroleum and chlorinated hydrocarbons. Time series observations of material collected between 1979 and 1982 showed that vertical mass and organic contaminant fluxes varied seasonally by an order of magnitude and corresponded with general cycles of zooplankton biomass and primary productivity in surface waters. Analyses of surface seawater including surface microlayer, dissolved and particulate phases are reported along with data from zooplankton, fecal material, and sediments collected near the trap station. Settling particles displayed two predominant patterns of petroleum hydrocarbons similar to the patterns of both 'dissolved' and 'particulate' hydrocarbons seen in surface seawater. Residence times of hydrocarbons in surface waters were computed according to recent partitioning models and compared with those calculated from the fluxes of actually settling particles and from sediment data. PCB fluxes calculated from sediment and settling particles averaged 2 to 4 ng/sq cm/yr with good agreement between data bases. Petroleum fluxes on settling particles averaged 8 micro-g/sq cm/yr but fluxes based on sediment concentrations showed that 90% of the petroleum hydrocarbons transported to depth were degraded before incorporation into compacted sediments. By evaluating fluxes and residence times with three independent data bases it is concluded that the biota are effective in transporting both particulate and dissolved organic contaminants to ocean sediments. Furthermore, the residence times of these materials in surface waters do not vary as much as would be predicted on the basis of their widely differing solubilities. (Author's abstract)
W86-01115

MODELLING KEPONE IN THE STRIPED BASS FOOD CHAIN OF THE JAMES RIVER ESTUARY,

Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
J. P. Connolly, and R. Tonelli.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 3, p 349-366, March, 1985. 8 Fig, 3 Tab, 50 Ref.

Descriptors: *Kepone, *Mathematical models, *Bass, *Food chain, *James River Estuary, Pesticides, Path of pollutants, Perch, Croaker, Sediment contamination, Bioaccumulation.

A mathematical model that computes the accumulation of Kepone in the striped bass food chain of the James River estuary was developed. The purpose of the model was to help understand the relationship of Kepone levels in important fish species to sediment and water column Kepone concentrations and then to address the question of why these levels still exceed Food and Drug Administration limits eight years after discharge ceased. The model considers exposure through diet and respiration at rates based on species bioenergetics. It was successfully calibrated to the Kepone concentrations observed in the period 1976 through 1982 in striped bass, white perch, and Atlantic croaker. The model indicates that for the upper levels of the food chain, diet is the major route of contamination, accounting for 87-88% of the observed concentration in croaker and white perch and 91% of the observed concentration in striped bass. The two Kepone sources; sediment and water column, contribute approximately equally to the croaker and white perch. The water column is more significant for striped bass, being the original source for approximately 60% of the observed body burdens. It was estimated that a criterion requiring Kepone concentrations in fish to be at or below 0.3 micro-g/g would require dissolved water column and sediment Kepone concentrations to be reduced to somewhere between 3 and 9 ng/l and 13-39 ng/g, respectively, depending on the species. Striped bass require the greatest reductions in dissolved water column and sediment Kepone concentrations to somewhere between 3 and 5 ng/l and 13 and 24 ng/g, respectively. (Author's abstract)
W86-01116

ARSENIC INCORPORATION IN A SALT MARSH ECOSYSTEM,

Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
J. G. Sanders, and R. W. Osman.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 4, p 387-392, April, 1985. 1 Fig, 2 Tab, 12 Ref.

Descriptors: *Arsenic, *Cedar Creek, *Delaware Bay, *Salt marshes, *Metals, *Fate of pollutants, Arsenate, Spartina, Estuarine environment, Adsorption, Bioaccumulation.

There are few studies of arsenic distribution in the various components of salt marsh ecosystems and even fewer studies of the impact of elevated arsenic concentrations on arsenic incorporation within the various ecosystem components. Replicate portions of Cedar Creek, a Delaware Bay salt marsh, were enclosed in cylindrical microcosms and exposed to elevated levels of inorganic arsenic (arsenate). Eight open-end fiberglass cylinders were forced into the marsh sediments to a depth of 10 cm at the water's edge, 60 cm below high water. Arsenate solution was added semi-diurnally to every other cylinder for nine days so that concentrations within the treated cylinders would be approximately 50 micro-g/l. All biotic and abiotic components in dosed cylinders rapidly incorporated arsenic. Spartina blades showed the greatest arsenic enrichment, with dosed plants incorporating arsenic concentrations an order of magnitude higher than controls. Spartina detritus and sediments also exhibited greatly elevated arsenic concentrations. Virtually all of the arsenic was incorporated into plant tissue or strongly sorbed to cell surfaces. High enrichment factors can occur in dead and living grass material. Increases in biologically available arsenic occur in the grasses, detritus, and sediment components of the ecosystem. Eighty-one percent of the arsenic was biologically

available. The enrichment factors measured (2-13) are quite large considering the short duration of the experiment, and may be extremely important. Elevated arsenic concentrations in estuarine waters will be reflected in living and non-living components of a salt marsh ecosystem, implying that increased arsenic will be available to organisms within the marsh ecosystem. (Collier-IVI)
W86-01118

EFFECTS OF DISSOLVED ORGANIC MATTER ON THE AQUEOUS PARTITIONING OF POLYNUCLEAR AROMATIC HYDROCARBONS,
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
B. Whitehouse.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 4, p 393-402, 1985. 4 Tab, 39 Ref.

Descriptors: *Dissolved organic matter, *Organic matter, *Polynuclear aromatic hydrocarbons, *Hydrocarbons, *Fate of pollutants, Chemical reactions, Phenanthrene, Anthracene, Benzanthracene, Benzo(a)pyrene.

The partitioning of six polynuclear aromatic hydrocarbons (PAH) into aqueous solutions containing dissolved organic matter (DOM) from various coastal environments was investigated by liquid chromatography. Samples were obtained from the Sargasso Sea, the Scotia Shelf, the Bedford Basin, Cole Harbor Saltmarsh, and Lake Robinson Brook and samples of terrestrial runoff were also obtained. In the laboratory, samples were filtered through a precleaned all glass filtering apparatus using precombusted glass fiber filter. DOM was operationally defined as that which passes through a Whatman GF/C glass fiber filter. Specific hydrocarbon-organic matter interactions were observed. The data indicate that the PAH investigated do not undergo significant interaction with oceanic DOM at natural concentrations. The greatest interactions occurred with the very low solubility hydrocarbons and with organic matter of terrestrial origin. Ultrafiltration experiments suggested that it was the relatively high (greater than approximately 500) molecular weight organic matter that was interacting with the hydrocarbons. Phenanthrene and anthracene are not affected by DOM from a near shore marine environment at natural concentrations and phenanthrene probably does not undergo considerable interaction with terrestrially derived DOM. Anthracene does significantly interact with terrestrial DOM. 1,2-Benzanthracene and benzo(a)pyrene show a significant interaction with a variety of DOM. PAH as a class of compounds can not be concluded to interact with naturally occurring DOM. The interactions are specific with respect to the compound involved and the environment from which the DOM is obtained. (Collier-IVI)
W86-01119

EFFECTS OF WIND, PHYTOPLANKTON AND DENSITY DISCONTINUITIES UPON AMMONIA DISTRIBUTIONS IN LIVERPOOL BAY,
University Coll. of North Wales, Menai Bridge. Marine Science Labs.
For primary bibliographic entry see Field 2L.
W86-01120

OXYGEN BALANCES IN THE TELTOW-CANAL - WITH SPECIAL REGARD TO HEAT DISCHARGE FROM LICHTERFELDE POWER PLANT (BERLIN, WEST) (SAUERSTOFFBILANZEN IM TELTOWKANAL - INSBESONDERE UNTER DEM EINFLUSS DER ABWARMEEINLEITUNG AUS DEM KRAFTWERK LICHTERFELDE (BERLIN, WEST)),
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
G. Klein, and H. Schumann.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 18, No. 3, p 130-140, June, 1985. 10 Fig, 4 Tab, 7 Ref.

Descriptors: *Oxygen balance, *Teltow Canal, *Lichterfelde Power Plant, *Berlin, *Germany (Federal Republic), Thermal pollution, Water pollution effects, Fate of pollutants, Chemical reactions.

The Teltow Canal in Berlin (West) has received the effluents of 4 sewage treatment plants, the storm water runoff from about 110 sq km of urban area and the heat discharge from three big power plants. A long term measuring program served data on water quality of the canal. The continuously registered O2-concentrations and temperatures were utilized for the calculation of a temperature coefficient for oxygen consumption. Comparing differently heated parts of the canal throughout the year, we found extremely high coefficients with a mean value of 1.34/C for 1982. Rapid changes in temperature during winter and spring (up to 10 C) resulted in the highest coefficients, which could be interpreted as the activation of additional O2-consuming processes (e.g, nitrification in winter). Measures for a more efficient sewage treatment and for the restoration of the oxygen budget are discussed. (Author's abstract)
W86-01141

DIFFUSION COEFFICIENT EVALUATED FROM THE DISTRIBUTION OF NONCONSERVATIVE MATERIAL (IN JAPANESE),
Kagoshima Univ. (Japan). Faculty of Fisheries.
H. Ichikawa, and M. Chaen.
Memoirs of the Faculty of Fisheries, Kagoshima University, Vol. 33, No. 1, p 1-11, December, 1984. 5 Fig, 7 Ref.

Descriptors: *Diffusion coefficients, *Nonconservative material, *Fish farming, *Ushine, *Kagoshima Bay, *Japan, Path of pollutants, Fate of pollutants, Aquaculture, Model studies.

The horizontal eddy diffusion coefficient (DC) is estimated from the distribution of nonconservative material (NM) near a fish-cultivation area taking into account the material discharge, reduction, descending speed of material, and advection by horizontal and vertical water motion. The differential equation about DC is formulated and solved under the following conditions. 1) Consider in the vertical two-dimensional plane of which length is 'L' and the depth 'H'. 2) The distribution of NM is steady and uniform in the longshore direction. 3) The reduction rate, gamma, and the descending speed, W, are uniformly constant. 4) The production, q, has a constant value only in a limited region below the fish cages. The value of q corresponds only to the total NM discharge, T, into the sea by fish cultivation. 5) At z = H, the material dispersion due to vertical diffusion is much smaller than those due to descending and vertical advection. 6) The concentration of NM vertically averaged from z = 0 to H, c, can be represented by c(x) = (C sub o) exp (-alpha squared X x squared). 7) The ratio beta of (C) sub H to c is constant, where (C) sub H is the NM concentration at z = H. 8) The x and z components of mean current velocity, u and (w) sub H can be represented as follows, respectively: u(x) = ((u sub o) X x/L), (w) sub H = ((-u sub o) X H/L). The solution is applied to Ushine area, in the inner part of Kagoshima Bay. The distribution of COD concentration observed in summer of 1977 is used in the estimation of DC. By adopting the parameters to be as follows, H = 20 m, L = 3 km, alpha = 0.000003/cm, C sub o = 5.8 x 10 to the minus 7th power g/cu cm, beta = 0.8, T = 3 ton/day, gamma = 0.01/day, W = 0.3 m/day, and u sub o = 0.5 cm/sec, the value of DC at x = L is calculated to be 161,000 sq cm/sec, of which order of magnitude agrees with that evaluated from the data obtained by the direct measurement of current velocity for a month in summer of 1979 at the 10 m layer of the Ushine area. The total discharge or production, descending speed of material, reduction rate and water motion have the same order of magnitudes of contributions to the evaluated diffusion coefficient. (Author's abstract)
W86-01143

ECOLOGICAL SURVEY OF SEDIMENT FLUX IN COASTAL FISH FARMS - I DECOMPOSITION FEATURES OF THE FLUX (IN JAPANESE),
Kagoshima Univ. (Japan). Faculty of Fisheries.
S. Kadowaki, Y. Inazuka, and H. Hirata.
Memoirs of the Faculty of Fisheries, Kagoshima University, Vol. 33, No. 1, p 43-49, December, 1984. 4 Fig, 2 Tab, 14 Ref.

Descriptors: *Sediment flux, *Fish farms, *Aquaculture, Decomposition, Nutrients, Organic carbon, Nitrogen, Phosphates.

In order to know the decomposition mechanisms of sedimented matter in a coastal fish farm, chemical features of the sediments were observed in comparison with non-fish farm areas. The observations were conducted in December 1980 and August 1981 in the vicinity of the Fisheries Research Laboratory, Kagoshima University. Two-liter-traps were submerged at 1 m, 5 m and 10 m from the sea bottom. The periods of suspension were set to be 1 day, 2 days, 4 days, 7 days and 10 days. Organic carbon, organic nitrogen and total phosphate were analyzed in each observation. Typical examples of the sediment decomposition were observed in 1-day-suspensions of the traps. In August, average organic carbon in fish farm and non-fish farm samples were 15.6 and 5.6 g/sq m/day, respectively. Organic nitrogen concentrations in August were 1.7 g/sq m/day in fish farm and 0.7 g/sq m/day in non-fish farm. Total phosphate, 1.9 g/sq m/day, in fish farm was nineteen times higher that that in non-fish farm. The results obtained in December showed almost the same trends as mentioned above. The decomposition coefficient of organic flux in deep layer, however, was 30-70% higher than that in case of August. (Author's abstract)
W86-01145

SEASONAL CHANGES IN THE DISTRIBUTION OF HETEROTROPHIC BACTERIA IN KAGOSHIMA BAY,
Kagoshima Univ. (Japan). Faculty of Fisheries.
T. Hidaka.
Memoirs of the Faculty of Fisheries, Kagoshima University, Vol. 33, No. 1, p 85-96, December, 1984. 2 Fig, 3 Tab, 18 Ref.

Descriptors: *Kagoshima Bay, *Japan, *Seasonal distribution, *Heterotrophic bacteria, Bacteria, Seawater, Water pollution, Public health.

Seawater samples were collected from 1m, 25m, 50m, and 100m depth layers at 8 stations along the center line of Kagoshima Bay 17 times in selected seasonal intervals during 1977 to 1984. The heterotrophic bacterial cells in the samples were estimated with the plate count method by surface spreading. The microbial cell counts were most abundant at the inner area of the bay in a horizontal distribution, and were most at the 1m deep layer in vertical distribution. They were more abundant in spring and summer than autumn and winter on a seasonal change basis. The range of bacterial numbers in the seawater samples was 10-1,000 cfu/ml. These results mean that the seawater at the sampling stations of Kagoshima Bay has not been polluted very much as yet. (Author's abstract)
W86-01147

SEASONAL CHANGES IN THE GENERIC COMPOSITION OF HETEROTROPHIC BACTERIA IN SEAWATER OF KAGOSHIMA BAY (IN JAPANESE),
Kagoshima Univ. (Japan). Faculty of Fisheries.
T. Hidaka, and S. Shimazu.
Memoirs of the Faculty of Fisheries, Kagoshima University, Vol. 33, No. 1, p 97-105, December, 1984. 67 Fig, 10 Ref.

Descriptors: *Seasonal variation, *Heterotrophic bacteria, *Kagoshima Bay, *Japan, *Bacteria, *Seawater, Fate of pollutants, Pseudomonas, Vibrio, Moraxella, Species composition.

The heterotrophic bacterial flora was sampled in seawater samples collected from the stations of Kagoshima Bay, during 1981 to 1983. The dominant genera in the seawater were Pseudomonas and Vibrio, almost similar to that of open sea water. In the generic compositions, Pseudomonas was the highest in seawater of the inner area of the bay and decreased approaching the entrance; in contrast, the ratio of Vibrio increased. This was confused sometimes, after rainy days, at the stations (St. 3 and 4) near Kagoshima city. In this

case, Moraxella significantly became the most dominant genus, indicating the slight pollution of seawater of this area during a few days. However, the seawater along the center line of Kagoshima Bay was generally not polluted. (Author's abstract)
W86-01148

ECOTOXICOLOGICAL ASPECTS OF PULP AND PAPER MILL EFFLUENTS DISCHARGED TO AN INLAND WATER SYSTEM: DISTRIBUTION IN WATER, AND TOXICANT RESIDUES AND PHYSIOLOGICAL EFFECTS IN CAGED FISH (SALMO GAIRDNERI),
Helsinki Univ. (Finland). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W86-01161

CONSIDERATIONS ON WATER, OIL AND AIR IN POROUS MEDIA,
Electrowatt Engineering Services Ltd., Zurich (Switzerland).
H. O. Schiegg.
Water Science and Technology, Vol. 17, No. 4/5, p 467-476, 1985. 7 Fig, 3 Ref.

Descriptors: *Groundwater pollution, *Porous media, *Oil pollution, Path of pollutants, Observation wells, Aquifers, Capillary height.

Oil spilled above a phreatic aquifer initially percolates primarily vertically until it reaches the capillary fringe. Subsequently, the oil migrates within the capillary fringe parallel to the groundwater table thereby creating an oil-polluted layer parallel to the groundwater table. The mean thickness of such an oil-polluted layer is denoted by H. The average thickness, H, of an oil-polluted layer parallel to the groundwater table is not equal to the thickness of oil in an observation well. H can be described as a function of the mean capillary height for water in air and of the oil potential or the thickness of oil in an observation well. The necessary thickness of oil on water for oil to enter a porous medium equals twice the mean capillary height of the water saturation curve which is encountered by the propagating oil. (Moore-IVI)
W86-01176

FACTORS CONTROLLING THE SURVIVAL OF VIRUSES IN GROUNDWATER,
Arizona Univ., Tucson. Dept. of Microbiology.
M. V. Yates, and C. P. Gerba.
Water Science and Technology, Vol. 17, No. 4/5, p 681-687, 1985. 4 Fig, 4 Tab, 9 Ref.

Descriptors: *Viruses, *Groundwater pollution, Bacteriophage, Temperature effects, Hardness, Hydrogen ion concentration, Nitrates, Ammonia, Turbidity, Dissolved solids, Calcium, Magnesium.

Viral contamination of groundwater is controlled by two major factors: migration and survival. This study used the coliphage MS-2, which is similar in size and structure to many enteric animal viruses, to identify factors which could be used to predict virus survival in groundwater. Groundwater samples collected from throughout the United States were inoculated with the coliphage MS-2 and the rate of virus inactivation determined. All samples were incubated at the temperature of the native groundwater. All samples were analyzed for pH, nitrates, ammonia, turbidity, total dissolved solids, and calcium, magnesium and total hardness. Multiple regression analysis of the chemical variates indicated that temperature and calcium hardness were significantly correlated with the rate of virus die-off. Temperature alone account for 60% of the variation in decay rate. Using all variates, 94% of the variation could be predicted. The presence or absence of microorganisms had an inconsistent effect on the survival of MS-2. (Moore-IVI)
W86-01192

COLLOIDAL STABILITY OF PARTICLES IN LAKES: MEASUREMENT AND SIGNIFICANCE,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 2H.
W86-01194

SORPTION OF AMMONIA NITROGEN ON RIVER BORNE SUSPENDED SOLIDS,
Purdue Univ., Lafayette, IN. Environmental Engineering Lab.
R. F. Wukasch, and L. P. Moos.
Water Science and Technology, Vol. 17, No. 4/5, p 713-718, 1985. 2 Fig, 5 Tab, 3 Ref.

Descriptors: *Fate of pollutants, *Ammonia, *Sorption, *Suspended solids, Wabash River, Indiana, Desorption, Rivers.

Many of the rivers in the midwestern U.S. carry a fairly high level of suspended solids. The ammonia nitrogen carrying capacity of suspended solids collected from the Wabash River (Indiana) was evaluated. Ammonia nitrogen was found to be both sorbable and desorbable from Wabash River suspended solids collected both in summer and in winter. The sorption of ammonia onto river solids was found to follow a Langmuir model and to be reversible. At background river ammonia concentrations of below about 0.2 mg/l, sorbed ammonia carried by the suspended solids is quite low, less than 0.2 mg NH3-N per gm suspended solids. Near outfalls under the right conditions, as much as 15 to 20% of the ammonia discharged may be initially sorbed from solution to be later released downstream when the soluble ammonia concentration decreases. (Moore-IVI)
W86-01195

HAZARDOUS SUBSTANCES IN WASTE WATER,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 5D.
W86-01225

STREAM MODELING OF NONCONVETIONAL WATER QUALITY PARAMETERS: PHENOL, CYANIDE, AMMONIA, OIL AND GREASE,
Yarmouk Univ., Irbid (Jordan). Dept. of Civil Engineering.
A. B. M. Shahalam, and D. A. Burke.
Water Science and Technology, Vol. 17, No. 6/7, p 953-966, 1985. 18 Fig, 2 Tab, 3 Ref.

Descriptors: *Phenols, *Cyanide, *Ammonia, *Oil, *Grease, *Stream pollution, *Mathematical models, Fate of pollutants, Decomposition, Multiple regression analysis, Hydraulic transport, Mass balance, Water quality.

Due to complexities in water uses in modern time, water quality management often needs much information in addition to the traditional DO and BOD data, to impose any kind of control on the industrial and municipal discharges into natural streams. The simplistic Monod type of substrate limiting kinetics are not sufficient to express the fate of complex chemicals such as phenol, cyanide, ammonia, oil and grease. This paper presents the kinetics of physical and biological degradation and transformation of such chemicals in natural waters. The kinetics were developed through multiple regression analysis using data monitored over a year from a river in Pennsylvania, USA. The conventional unidirectional hydraulic transport and mass balance equations were then combined with these kinetics to predict the steady state water qualities in various reaches of the river under a specific set of known external discharges. When compared to the monitored water quality data under that specific set of external discharges, the predictions were found to be satisfactory. Some disagreement was observed in cyanide concentrations in the most downstream section of the 25 mile stretch of river. (Author's abstract)
W86-01234

WATER QUALITY MODELLING OF THE LOWER HAN RIVER, KOREA,
Engineering-Science, Inc., Arcadia, CA.
L. F. Tischler, R. M. Bradley, S. J. Park, and D. G. Rhee.
Water Science and Technology, Vol. 17, No. 6/7, p 979-990, 1985. 4 Fig, 1 Tab, 5 Ref.

Descriptors: *Han River, *Korea, *Water quality, *Computer models, Wastewater pollution, Hydraulic properties, Simulation, Mathematical models, Urban areas, Model calibration.

The Han River Basin in the Republic of Korea covers an area of about 27,000 sq km south of the Demilitarized Zone, almost one quarter of the total area of the country. The total population in the basin is of the order of 13 million, of which more than 80 percent are concentrated in the urban conurbation of Greater Seoul alongside the Lower Han River. Within the vicinity of Seoul the river is used extensively for water supply, irrigation and both contact and non-water contact recreation. Treated nightsoil, untreated sullage, partially treated sewage and industrial wastes generated in the urban areas are also discharged to the river which is heavily polluted in the downstream reaches as a result. The finite difference water quality model QUAL-II was adapted to the Lower Han River using data obtained from extensive field water quality surveys especially designed to provide the necessary calibration and verification data base. Hydraulic data for the model were obtained from operation of the U.S. Army Corps of Engineers HEC-II computer model. Model calibration and verification was confirmed by statistical comparison of model simulations with the field data. The calibrated model was used to evaluate a number of different treatment alternatives for two different future years. Extensive model sensitivity analyses were run on both the key model parameters and the treatment alternatives to quantify the reliability of the prediction. (Author's abstract)
W86-01236

TIDAL VARIATION OF SALT FLUX AND DISPERSION IN A POLLUTED ESTUARY,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W86-01238

FACTORS AFFECTING THE ADSORPTION OF COMPLEXED HEAVY METALS ON HYDROUS AL2O3,
Delaware Univ., Newark. Dept. of Agricultural Engineering.
H. A. Elliott, and C. P. Huang.
Water Science and Technology, Vol. 17, No. 6/7, p 1017-1028, 1985. 5 Fig, 1 Tab, 23 Ref. NSF grants ENG-77-27379 and ENG-79-10483.

Descriptors: *Heavy metals, *Adsorption, *Alumina, Fate of pollutants, Copper, Zinc, Cadmium, Lead, Nickel, Calcium, Magnesium, Temperature effects, Ionic strength.

Factors influencing the adsorption behavior of heavy metals, viz Cu(II), Zn(II), Cd(II), Pb(II) and Ni(II), onto Al2O3 from aqueous solutions containing complexing ligands were investigated using batch adsorption experiments. For the Cu(II)/NTA/gamma-Al2O3 system, increasing the system ionic strength reduced Cu adsorption through activity coefficient and surface electrical double layer effects. The presence of alkaline earth cations (Ca(II) and Mg(II)) also reduced Cu removal from solution by lowering the ability of NTA to prevent Cu(OH)2 precipitation and through specific adsorption to the alumina surface. The adsorption of the heavy metals on Al2O3 from solutions containing NTA followed the sequence: Cu > Zn > Cd > Pb approximately = Ni. Increase in system temperature tended to decrease metal adsorption. (Author's abstract)
W86-01239

CONTRIBUTION OF AGRICULTURAL LOADING TO EUTROPHICATION IN FINNISH LAKES,
National Board of Waters, Helsinki (Finland).
L. Kauppi.
Water Science and Technology, Vol. 17, No. 6/7, p 1133-1140, 1985. 4 Fig, 1 Tab, 15 Ref.

Descriptors: *Finland, *Agriculture, *Eutrophication, *Pollution load, Limiting nutrients, Phosphorus, Nonpoint pollution sources, Runoff, Desorption.

Agriculture accounts for 9 per cent of the total surface area of Finland and generates the greatest single nutrient input to Finnish watercourses. Since agricultural activity is scattered throughout the whole country its effects in lakes are less pronounced than those of domestic and industrial effluents. On the other hand, point source phosphorus loading of lakes and rivers decreased significantly during the nineteen-seventies. Phosphorus is the nutrient which primarily limits production in most Finnish lakes. The availability of phosphorus in agricultural runoff waters is therefore a crucial question in the evaluation of the eutrophicating effects of agriculture. The results indicated that in runoff waters available phosphorus can be 60-70 per cent of the total phosphorus. However, the concentrations of available P were so low that they could be achieved in Finnish lakes of low ionic concentration through simple chemical desorption without the assistance of the algal uptake. The utilization of the spring maximum of runoff phosphorus in lakes would thus not depend on the concurrence of the maxima of loading and algal growth. (Author's abstract)
W86-01247

MODELING WATER QUALITY AND THE EFFECTS OF AGRICULTURAL BEST MANAGEMENT PRACTICES IN THE IOWA RIVER BASIN,
Anderson-Nichols and Co., Inc., Palo Alto, CA.
For primary bibliographic entry see Field 5G.
W86-01248

SURFACE WATER QUALITY IN RELATION TO SOIL TYPE, LAND USE AND DISCHARGE IN A RURAL CATCHMENT AREA,
Utrecht Rijksuniversiteit (Netherlands). Environmental Research Group.
M. C. H. Witmer.
Water Science and Technology, Vol. 17, No. 6/7, p 1155-1164, 1985. 6 Fig, 4 Tab, 6 Ref.

Descriptors: *Water quality, *Surface waters, *Soil type, *Land use, *Rural areas, *Flow discharge, Catchment area, Water pollution sources, Wastewater pollution, Base flow, Flood peak, Canals, Nutrients, Drainage, Potassium, Nitrates, Orthophosphates, Water quality control.

Surface water quality and the factors that influence it were investigated in a rural area that lies between an ice-pushed ridge and river backlands. The influences of soil type, land use and household wastewater on the concentrations of nutrients were studied during base-flow as well as peak-flow periods. Samples were taken in ditches and canals, more frequently as discharge increased. Average values of the base-flow quality in ditches were calculated for soil type and land use and for all measure points in the canals. The fluctuations of water quality were plotted and analyzed in concentration-time and concentration-discharge diagrams. The relative importance for the quality of total discharge in the main canal of the loads coming from several parts of the drainage basin was investigated with a stepwise multiple variable regression analysis. During base-flow situations sources of nutrients are the intensively cultivated sandy soils. In addition the concentration of orthophosphate is increased by household wastewater. During peak-flows, potassium and nitrate run off from all soil types with all types of land use, resulting in high concentrations in the surface water, in spite of dilution by rainwater. It is concluded that for proper management, intensity of manuring and fertilizing should decrease, especially on sandy soils. Wastewater should be drained outside the basin, to lower the concentration of orthophosphate. (Author's abstract)
W86-01249

CHRONIC POLLUTION OF INTERCITY MOTORWAY RUNOFF WATERS,
Laboratoires Regionaux des Ponts et Chaussees, Paris (France).
J. D. Balades, M. Cathelain, P. Marchandise, J. Peybernard, and J. C. Pilloy.
Water Science and Technology, Vol. 17, No. 6/7, p 1165-1174, 1985. 10 Tab, 15 Ref.

Descriptors: *Highways, *Runoff, *Water pollution sources, Pollution load, Standards, France, Rainfall, Roads.

From 1980 to 1982, two investigations of the chronic pollution of roadway runoff water were carried out in areas having different pluviometric characteristics. The runoff from two hundred pluviometric events was characterized using highly rigorous methodologies, with a view to estimating the annual pollution load. The annual loads were determined; they show that the (French) official instructions hither-to followed were rather pessimistic. On the other hand, greater vigilance is required as regards the loads that may be contributed by an isolated event, but it is not possible to characterize the parameters that will give rise to such an event. A few rain events can introduce into the environment, in short time, as much as 30% of the annual pollution load of motorway runoff waters. (Author's abstract)
W86-01250

METAL MOBILIZATION IN HOME WELL WATER SYSTEMS IN NOVA SCOTIA,
Dalhousie Univ., Halifax (Nova Scotia). Inst. for Resource and Environmental Studies.
O. Maessen, B. Freedman, and R. McCurdy.
Journal of the American Water Works Association, Vol. 77, No. 6, p 73-80, June, 1985. 2 Fig, 4 Tab, 41 Ref.

Descriptors: *Well water, *Nova Scotia, *Metals, *Plumbing, Pipes, Metal mobilization, Water quality, Drinking water, Copper, Zinc, Lead, Cadmium, Heavy metals, Leaching.

A study of private wells in rural Nova Scotia found that concentrations of metals such as cadmium, zinc, copper, and lead increased in water that remained in the distribution system overnight. Metal mobilization of copper, lead, and zinc occurred in significant amounts from the plumbing systems of the homes sampled. In many cases this leaching caused concentrations of copper and lead to be in excess of the recommended Canadian drinking water limits within only a few hours of standing in the water pipes. Water samples containing copper and lead concentrations in excess of the recommended limits were obtained from a large proportion of the homes sampled in each of the four communities studied. The amount of metal mobilization varied greatly from house to house but, on average, the absolute amount of metal mobilization did not differ among the homes in the four communities. Correlation analyses helped to confirm that indexes commonly used to assess the corrosive tendency of a water were not good predictors of the degree of metal leaching that could occur in a given water. Stepwise multiple regression analyses helped to identify 12 water chemistry variables as being related to the degree of metal mobilization observed. These were potassium, sodium, calcium, magnesium, and manganese; the chloride, nitrate, hydrogen and sulfate ions; and dissolved oxygen, and conductivity. No obvious generalized relationship was found between the pH of the water and the degree of metal leaching. Because of the high concentrations of copper and lead found in samples of standing water it is recommended that residents in homes with metal piping allow the water in the pipes to flush for several minutes before use in the morning or if the water has not been used for several hours. (Baker-IVI)
W86-01264

NITROGEN TRANSFORMATIONS IN THE BALTIC PROPER: DENITRIFICATION COUNTERACTS EUTROPHICATION,
Goeteborg Univ. (Sweden). Dept. of Microbiology.
U. Ronner.
Ambio, Vol. 14, No. 3, p 134-138, 1985. 4 Fig, 2 Tab, 39 Ref.

Descriptors: *Baltic Sea, *Nitrogen, *Eutrophication, *Denitrification, Water pollution, Nitrogen removal, Marine environment, Fate of pollutants, Bacteria, Phytoplankton.

Nitrogen plays an important role in marine eutrophication and its increased addition to the Baltic Sea by human activities could upset the ecosystem if its loss from the system is also not substantial. The major process of nitrogen loss is denitrification, a bacterial process that converts nitrate to nitrogen gas during anoxic or near-anoxic conditions. A budget is presented which is based on rate measurements for many processes and gives improved estimates for denitrification. A general diagram of the nitrogen flow in the Baltic ecosystem is pictured. Inputs to the Baltic proper include atmospheric deposition, river runoff, diffusive and advective transport - external, and nitrogen fixation. Nitrogen transformations within the Baltic proper include phytoplankton biomass and assimilation, microbial biomass and mineralization, nitrification, and diffuse and advective transport - internal. Outputs from the Baltic proper include nitrogen gas, immobilization, transport by surface currents, and emission of nitrous oxide to the atmosphere. The controlling factors for denitrification below the halocline of the Baltic are clearly oxygen and nitrate, while denitrification above the halocline probably is stimulated by increasing amounts of nitrate from land. In the Baltic proper today, organic nitrogen seems so far to be efficiently transformed, via ammonium and nitrate, to nitrogen gas. Thus denitrification seems to be preventing excessive eutrophication by removing nitrogen, the limiting nutrient for primary production. The reported budget illustrates the potential importance of denitrification in controlling eutrophication in the Baltic, and emphasizes the necessity for further studies in this area. (Baker-IVI)
W86-01278

INDICATIONS OF THE CAPACITY FOR RAPID REVERSIBILITY OF LAKE ACIDIFICATION,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
C. Forsberg, G. Morling, and R. G. Wetzel.
Ambio, Vol. 14, No. 3, p 164-166, 1985. 3 Fig, 3 Tab, 15 Ref.

Descriptors: *Acid lakes, *Acidification, *Acid rain, *Sulfates, *Sweden, *Water pollution effects, Water pollution sources, Hydrogen ion concentration, Nitrous oxides, Lakes.

Acidification in a number of lakes in western Sweden reached a maximum during the middle of the 1970s, with sulfate concentrations of 270 to 290 micro-eq/l and pH values of 4.4 to 4.5. In 1977 this trend reversed, and decreases in the concentrations of sulfate and hydrogen ions were observed. The main reason for this partial improvement, 0.3 to 0.4 pH units at most, was a decrease in wet deposition of sulfate; the observed decrease was about 20 percent at the meteorological sampling location Bohus Malmon, in western Sweden. In contrast to the wet deposition of sulfate, the wet deposition of hydrogen ions increased, probably as a result of increased emissions of nitrous oxides. A sulfate reduction of 40-100 micro-eq/l was found for several lakes. There was a correlation between sulfate and H(+) during both the acidification and deacidification phases. Of special interest is the hysteresis that occurs between these phases. When sulfate concentrations had decreased to previous levels, H(+) values were higher than during the acidification phase. Increased precipitation, which was also more acid, counteracted the improvements obtained by reduced sulfate concentration. It was concluded that sensitive lakes appear able to begin recovery quickly when sulfate concentration are reduced. (Author's abstract)
W86-01279

BIOSPHERE LEVELS OF CADMIUM, ZINC AND COPPER AROUND AN OLD SWEDISH COPPER MINE,
Linkoeping Univ. (Sweden). Dept. of Pharmacology.
For primary bibliographic entry see Field 5C.

W86-01280

MULTIVARIATE ANALYSIS OF WATER CONTAMINATION BY HEAVY METALS AT DONANA NATIONAL PARK,
Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Quimica Organica General.
J. Gonzalez, L. M. Hernandez, A. Hernan, and G. Baluga.
Bulletin of Environmental Contamination and Toxicology, Vol. 35, p. 266-271, August, 1985. 3 Fig, 2 Tab, 9 Ref.

Descriptors: *Heavy metals, *Donana National Park, *Water pollution sources, *Mines, Multivariate analysis, Mathematical studies, Cadmium, Mercury, Lead, Copper, Zinc.

Donana National Park (Spain) is a natural park about 60,000 Ha in size. It is a very important stopping ground and winter habitat for migratory birds that breed in northern Europe. One of the most important water supplies for the survival of the park is the Guadiamar River. The Agrio river is a tributary of the Guadiamr, and it flows across an important mining field which is currently in operation. The watershed was sampled to determine whether there was any possible contamination from the mining. Sampling points were located in the mining area, the marshes, and the stabilized sands. Cd, Pb, Cu and Zn pollution were found in the waters of the study area. Contamination was highest in the mining area, high in the northern side of the marshes, moderate in southern site of the marshes, and low in the stabilized sands. This conclusion is linked with the fact that the hydraulic system of the stabilized sands is independent from that of the marshes. The stabilized sands only depend on the rain and the subterranean waters. High Hg pollution was found throughout the area studied. (Baker-IVI)
W86-01286

BROMINATED PHENOLS AND ANISOLES IN RIVER AND MARINE SEDIMENTS IN JAPAN,
Osaka Prefecture Inst. of Public Health (Japan).
I. Watanabe, T. Kashimoto, and R. Tatsukawa.
Bulletin of Environmental Contamination and Toxicology, Vol. 35, p 272-278, August, 1985. 3 Fig, 1 Tab, 13 Ref.

Descriptors: *Phenols, *Anisoles, *Sediments, *Japan, Fate of pollutants, Organic compounds, Marine sediments, River sediments, Halogenated hydrocarbons, Tribromophenol, Tribromoanisole.

The environmental levels of brominated phenols have been determined along with chlorinated phenols in river and marine sediments collected from Osaka, Japan. The brominated and chlorinated anisole levels in the samples were also examined. At site no. 7 brominated phenols, were found in the samples along with chlorinated phenols. No dibromophenol was found. Also present in the sediment samples was 2,4,6-tribromoanisole along with chlorinated anisoles. The residue levels of halogenated phenols and anisoles in the sediment samples are given as determined on a dry weight basis. The brominated phenol levels were lower than those of the chlorinated phenols being about one-tenth the chlorinated phenols content. Tribromophenol was found in nearly all the samples analyzed and was thus considered an ubiquitous environmental contaminant, though its residue level is generally low. However, higher residue levels of this compound were found in the two sediment samples collected at sites 7 and 8, and were nearly the same as those of the organochlorinated pesticides. 2,4,6-Tribromoanisole was found in only two of the 12 samples analyzed and had a very low residue level. Other brominated anisoles were absent from the samples. Brominated phenol residue levels in sediment samples collected at sampling sites 7 and 8 were considerably higher than those collected at other sites. Sewage treatment plants were located in the vicinity of sampling sites 7 and 8. (Baker-IVI)
W86-01287

CALIBRATION OF A MASS TRANSPORT MODEL USING ENVIRONMENTAL TRITIUM,
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
J. C. Herweijer, G. A. Van Luijn, and C. A. J. Appelo.
Journal of Hydrology, Vol. 78, No. 1/2, p 1-17, May, 1985. 10 Fig, 14 Ref.

Descriptors: *Mass transport models, *Model studies, *Tritium, *Aquifers, Isotope studies, Path of pollutants, Groundwater contamination, Animal wastes.

Tritium profiles of groundwater were obtained by detailed vertical sampling of a 20-m thick aquifer comprising fluvioglacial sediments in the central part of The Netherlands. Using the known environmental tritium input time series since 1951, these profiles were used to calibrate the Random Walk model of T.A. Prickett et al. To perform this procedure the model was modified to allow vertical use and a time-dependent non-instantaneous input of a decaying radioactive tracer. During this calibration the following parameters were varied: (1) geological geometry (position and extent of a clay lens); (2) permeability variations; (3) ratio of net precipitation and effective porosity; and (4) longitudinal and transverse dispersivity. The calibrated model was hence used to predict the flushing of manure contamination from the aquifer. The applied calibration technique has proved useful to test and roughly calibrate the hydraulic properties estimated from the logs of a limited number of borings, with the accuracy needed for mass-transport modelling. Compared with the very detailed drilling program that is usually required to obtain such detailed information, this tritium-based calibration seems competitive for shallow phreatic aquifers. (Author's abstract)
W86-01289

SALT-WATER-FRESHWATER TRANSIENT UPCONING - AN IMPLICIT BOUNDARY-ELEMENT SOLUTION,
Kansas State Geological Survey, Lawrence.
M. Kemblowski.
Journal of Hydrology, Vol. 78, No. 1/2, p 35-47, May, 1985. 10 Fig, 13 Ref. U.S. Department of Interior, Bureau of Reclamation grant 4-FG-93-00080.

Descriptors: *Saline water intrusion, *Saline-freshwater interfaces, *Upconing, *Implicit solutions, *Boundary element solutions, Boundary conditions, Aquifers, Groundwater contamination, Model studies.

The most difficult part of the modeling of salt-water intrusion is the simulation of the motion of the transition zone between fresh and salt water. If the width of the transition zone is relatively small compared to the aquifer thickness, the sharp-interface approximation may be introduced. The boundary-element method was used to solve the set of partial differential equations describing the flow of salt water and fresh water separated by a sharp interface in the vertical plane. In order to improve the accuracy and stability of the numerical solution, a new implicit scheme was developed for calculating the motion of the interface. The solution does not use the Dupuit approximation, thus providing a better model for the cases in which the vertical component of the flow is significant. For the simulation of the interface motion, a special implicit scheme was developed, which gives substantially better results than the explicit solution. The performance of this scheme was tested by means of numerical simulation. The numerical results were compared to experimental results for a salt-water upconing under a drain problem. The numerical model may be used to analyze steady and unsteady, stable and unstable, salt-water upconing problems. (Collier-IVI)
W86-01291

MODELLING NON-POINT SOURCES OF NITRATE POLLUTION OF GROUNDWATER IN THE GREAT OUSE CHALK, U.K.,
Birmingham Univ. (England). Dept. of Geological Sciences.
M. A. Carey, and J. W. Lloyd.
Journal of Hydrology, Vol. 78, No. 1/2, p 83-106, May, 1985. 8 Fig, 3 Tab, 32 Ref.

Descriptors: *Model studies, *Nonpoint pollution sources, *Groundwater contamination, *Nitrates, *Great Ouse Chalk, *Cambridge, *England, Path of pollutants, Solute transport, Nutrients.

A numerical distributed transport model was used to simulate nitrate concentrations in groundwater. The model takes into account the nitrate input from the soil zone and the movement of nitrate in the unsaturated and saturated zones. The model was developed for an area of 600 sq km of the Cretaceous Chalk, near Cambridge, England. The model area is described in terms of geology, hydrogeology, land use and agricultural practice. The Chalk aquifer was represented by rectangular cells which are divided into an upper and lower layer to represent the unsaturated and saturated zone. The nitrate input from the soil zone was calculated. A simplified equation was used to account for the delay for nitrate to pass through the unsaturated zone. Nitrate concentrations in groundwater were determined using a mass-balance approach. The model results in the simulation mode and in the forecast mode are presented and discussed and the sensitivity of the model is examined. (Author's abstract)
W86-01294

QUALITY OF WATER IN AN AQUIFER AND ITS MANIFESTATION IN PUMPING WELLS,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Fisica.
For primary bibliographic entry see Field 2F.
W86-01299

ANALYSIS OF ORGANICALLY COMPLEXED ELEMENT CONTENTS IN SEDIMENTS AND SLUDGES (ZUR ANALYTIK ORGANISCH-KOMPLEXIERTER ELEMENTGEHALTE IN SEDIMENTEN UND SCHLAMMEN),
Goettingen Univ. (Germany, F.R.). Inst. fuer Anorganische Chemie.
For primary bibliographic entry see Field 7B.
W86-01301

NEW METHOD OF CONTAMINANT PLUME ANALYSIS,
Texas A and M Univ., College Station. Dept. of Geology.
P. A. Domenico, and G. A. Robbins.
Ground Water, Vol. 23, No. 4, p 476-485, July-August, 1985. 10 Fig, 11 Ref.

Descriptors: *Plumes, *Path of pollutants, *Model studies, Water analysis, Computers.

A methodology is presented which may be useful in the analysis of contaminant plumes. The calculations are relatively straightforward and easily programmed for microcomputer analysis, and the model can be manipulated to account for several spreading geometries. Most importantly, information on seven potential unknowns can be extracted directly from the concentration distribution, thereby providing a better physical basis for the model. Such procedures remove much of the nonuniqueness associated with contaminant plume analysis. As the information for the analysis is taken directly off the plume, the method can be applied to chemically retarded species without any regard to retardation coefficients. The model has limitations common to all analytic expressions, namely the isotropic and homogeneous assumptions along with an assumed constant velocity system. The data demands are rather large, and the calibration procedure discussed should be viewed as a first try estimate based on an extended pulse approximation that realistically cannot be expected to adequately describe all portions of a plume. (Baker-IVI)
W86-01309

MOVEMENT OF VOLATILE ORGANICS THROUGH A FRACTURED ROCK AQUIFER,
Geological Survey, Trenton, NJ. Water Resources Div.

S. E. Spayd.
Ground Water, Vol. 23, No. 4, p 496-502, July-August, 1985. 5 Fig, 13 Ref.

Descriptors: *Volatile compounds, *Chlorinated hydrocarbons, *Path of pollutants, *Groundwater pollution, *New Jersey, Aquifers, Geological fractures, Water pollution control, Pumping.

A detailed assessment or the movement of volatile organics through the Brunswick fractured rock aquifer was undertaken in response to the detection of contaminants in several municipal water supply wells in a northern New Jersey community. Company A is a manufacturer of cutting tools and has used various volatile organics including 1,1,1-trichloroethane, in its manufacturing process. Company B has been involved in the distillation and repackaging of various laboratory reagents and clinical solutions, including many volatile organics such as chloroform and carbon tetrachloride. Contaminants from Company A and B were transported downward through the overburden to the water table by infiltrating precipitation. The volatile organic compounds with relatively higher specific gravities were transported downward to the Brunswick Aquifer much more readily than those compounds with lower specific gravities. A pumping-to-waste program helped control the spread of contamination. The water quality patterns confirmed that the plumes were being captured by the cones of depression surrounding the pumping wells. Only very low levels were found southwestward of the pumping wells. Both Company A and B were sources of the trichoroethylene found in the aquifer. The wells oriented along strike with Company A were mainly contaminated by 1,1,1-trichloroethane and tetrachloroethylene with much lower concentrations of chloroform and carbon tetrachloride. Therefore, Company A was the principal source of the 1,1,1,-trichloroethane and tetrachloroethylene found in the aquifer. The wells oriented along strike with B were mainly contaminated by chloroform and carbon tetrachloride with much lower concentrations of 1,1,1-trichloroethane and tetrachloroethylene. Although limited in extent, some contaminated ground water had flowed in directions other than directly along strike, especially near the pumping wells. (Baker-IVI)
W86-01311

ESTIMATING VERTICAL SOIL MOISTURE FLUX AT A LAND TREATMENT SITE,
California Univ., Santa Cruz. Dept. of Applied Science.
For primary bibliographic entry see Field 2G.
W86-01312

SIMULATED SALT-WATER MOVEMENT IN THE NAKHON LUANG AQUIFER, BANGKOK, THAILAND,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 2F.
W86-01313

5C. Effects Of Pollution

PHYTOPLANKTON DYNAMICS IN A HYPERTROPHIC BRACKISH-WATER BAY,
Helsinki Univ. (Finland). Dept. of Limnology.
P.-E. Persson.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2203-2207, 1985. 3 Tab, 20 Ref.

Descriptors: *Phytoplankton, *Brackish water, *Bays, *Species composition, *Kaupunginselka Bay, *Stadsfjarden, *Poorvoo, *Finland. *Physicochemical characteristics, Cyanophyta, Algal growth, Biomass, Phytoplankton, Water temperature, Conductance, Nutrients, Water pollution effects, Transparency.

The interrelationships among phytoplankton community composition, phytoplankton biomass, primary productivity in vitro, water temperature, conductance (salinity), freshwater influx, and nutrient levels were examined in Kaupunginselka Bay (Stadsfjarden) at Poorvoo, Finland. The bay is a shallow, sewage-polluted, brackish embayment at the mouth of the River Porvoonjoki (Borga River), in which the growth of Oscillatoria agardhii has been a problem. Linear correlation coefficients were calculated among various phytoplankton and physicochemical parameters. For blue-green algae, nutrients and salinity were the main factors influencing biomass variations, whereas for green algae and diatoms, water temperature and salinity, respectively, appeared to be key factors. The factors influencing primary productivity reflected the Cyanophycean dominance of the phytoplankton. Freshwater discharge into the bay influenced phytoplankton through its effect on the rate of water renewal. A very significant correlation was seen between phytoplankton biomass and residence time of water in the bay (r=0.726**). The Cyanophycean dominance in the bay was partly due to low light environment; the Secchi disk transparency of 0.10-0.25 indicated a light environment favorable to 'shadow plants' like O. agardhii. Low correlation coefficients were exhibited by numerous environmental factors, which makes it impossible to select a key factor regulating phytoplankton succession in this area. (Rochester-IVI)
W86-00932

PATTERN RECOGNITION TECHNIQUES TO DETERMINE BENTHIC INVERTEBRATE TROPHIC AND COMMUNITY RESPONSES TO INDUSTRIAL INPUT,
Beak Consultants Ltd., Calgary (Alberta).
R. A. Crowther, and M. E. Luoma.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2226-2231, 1985. 2 Fig, 1 Tab, 8 Ref.

Descriptors: *Thunder Bay, *Ontario, *Ecological impact, *Water pollution effects, *Benthos, *Pulp and paper industry, Industrial wastewater, Species composition, Statistical analysis, Species distribution, Phenols, Oligochaetes, Midges, Mollusks.

The pattern recognition techniques of reciprocal averaging ordination (RAO) and discriminant analysis (DA) successfully defined the extent of, and placed boundaries between, areas of chronic and acute pollution associated with pulp and paper mill effluent in Lake Superior. Sediments of the nearshore environment of Thunder Bay, Ontario, Canada were sampled with an Ekman grab with the intention of assessing the appropriateness of a proposed limited use zone (LUZ), which had originally been established solely on the basis of phenolics concentration. The benthic fauna generally was dominated by Oligochaeta, Chironomidae, and Mollusca. Five sequences of benthic fauna were identified by RAO and DA; the sequences appeared to represent a trophic gradient from mesooligotrophy through eutrophy to chronic pollution. The principal causative agents for the observed faunal patterns were concentration gradients in dissolved solids, phenolics, wood fiber, and dissolved oxygen content. In comparison with the LUZ originally proposed, the area of actual system perturbation as shown by the benthos was much larger, although the area of chronic pollution effects was small. The proposed LUZ consisted of a roughly rectangular area extending 700 m offshore and about 1,200 m wide. The zone of influence according to benthos analysis indicated an irregularly-shaped zone of influence extending 1,300 m offshore with a width of 2,800 m. Numerical indices alone probably would not have yielded the results obtained in this study; ecological information and the pattern expressed by the fauna should be incorporated in studies of system perturbations. (Rochester-IVI)
W86-00934

ASBESTOS FIBERS IN LAKES AND STREAMS,
Vermont Univ., Burlington. Dept. of Zoology.
E. B. Henson.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2232-2237, 1985. 3 Fig, 16 Ref.

Descriptors: *Asbestos, *Water pollution effects, Chrysotile, Daphnia, Paramecia, Water analysis, Physical analysis, Microscopic analysis.

Chrysotile is the most common species of asbestos; literature on asbestos is voluminous, but little has been reported on the effects of this mineral on plants and animals in aquatic ecosystems. Several methods have been used for measuring the asbestos fiber content of water, including colorometric tests, light microscopy, polarized light microscopy, dispersion staining, x-ray diffraction, proton-induced x-ray emission, transmission electron microscopy, scanning electron microscopy, and selected area electron diffraction. Laboratory procedures for asbestos present problems because water acidity, high alkalinity, and methods of handling affect the size, and hence number, of fibers in a water sample. Concentrations of asbestos reported in natural waters range from undetectable (noncontaminated parts of Lake Champlain (USA)) to 1.200 x 10 to the 9th power/liter in water draining mines from the city of Asbestos, Quebec. In laboratory experiments, survivorship of Daphnia pulex was negatively correlated with concentration of chrysotile fibers over the range of approx 20-550 mg/l. Autopsies of the animals that died showed a clumping of fibers and congestion around the antennal setae and legs, which may have restricted swimming, and there was some evidence that the animals were impaled during feeding. Similar experiments with Paramecium in culture at various concentrations of asbestos fibers revealed no difference between controls and experimental cultures in terms of growth rate or asymptotes. (Rochester-IVI)
W86-00935

DIATOM COMMUNITIES OF THE POLLUTED RIVERS OF CENTRAL POLAND (LES COMMUNAUTES DES DIATOMEES DANS LES RIVIERES POLLUEES DE LA POLOGNE CENTRALE),
Lodz Univ. (Poland). Inst. of Environmental Biology.
B. Rakowska.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2319-2322, March, 1985. 2 Fig, 1 Tab, 3 Ref.

Descriptors: *Diatoms, *Water pollution effects, *Rivers, *Poland, Headwaters, Downstream, Ecological distribution, Industrial wastewater, Food processing industry, Bioindicators, Wastewater pollution.

Qualitative and quantitative analysis of the diatoms found in polluted rivers in Central Poland reveals that a small number of species are characteristic of the headwaters, and the number of species increases downstream. The rivers are polluted in the upper sectors. The influence of pollution on the diatom communities is evident in the river Bzura where the number of taxons are reduced two-fold and the number of individuals is reduced 100-fold. Downstream, the number of taxons and individuals increases with the improvement in physical and chemical conditions. In the rivers Rawka and Mroga, there is a simultaneous reduction in the number of taxons and the density of diatoms downstream of the point of introduction of effluents from the food processing industry. Analysis of the diatoms communities led to the establishment of a list of typical species for waters of different degrees and types of pollution; species are listed which have a great tolerance for physicochemical gradients. (Moore-IVI)
W86-00947

INFLUENCE OF ORGANIC POLLUTION ON THE MACROINVERTEBRATE COMMUNITIES OF MOUNTAIN STREAMS,
Innsbruck Univ. (Austria). Inst. fuer Zoologie.
M. Margreiter-Kownacka.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2324-2326, 1985. 1 Fig, 9 Ref.

Descriptors: *Organic matter, *Water pollution effects, *Mountain streams, *Macroinvertebrates, *Poland, *Sucha Woda, *Roztoka, *Rybi Potok, *Gurgler Ache, *Austria, Ecological effects, Phys-

icochemical characteristics, Benthos, Alpine regions.

Faunal composition in relation to pollution level was compared in the Tatra (Poland) streams Sucha Woda, Roztoka and Rybi Potok, and the alpine stream Gurgler Ache (Austria). The method employed included a detailed description of the stream or river and its basin, selection of research localities, a detailed description of the locality and its physico-chemical conditions, and standardization of sampling technique throughout. The dominant groups of macrofauna in the upper courses are Chironomidae (mainly Orthocladiinae in the Tatra springs and streams and Diamesinae in the alpine glacier-streams) and Ephemeroptera (mainly Baetis alpinus). Plecoptera constitute an av 5%. In the lower courses of the alpine streams Trichoptera play an important role. Under the influence of pollution the structure of the community changes. The influence occurs seasonally in Gurgler Ache where tourists are present mainly in winter. At a station on this stream where tourist influence was present, Ephemeroptera were a smaller part of the percentage composition and Chironomidae and Oligochaeta were a much larger part, than at another, unpolluted station. Plecoptera were also much less abundant at the polluted station, particularly in winter. (Rochester-IVI)
W86-00948

INFLUENCE OF THE SEWAGE TREATMENT PLANT EFFLUENTS ON THE STRUCTURE OF THE BENTHIC COMMUNITIES OF LAKE OF GENEVA,

Geneva Univ. (Switzerland). Unite de Biologie Aquatique.
B. Crozet.

Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2327-2331, 1985. 2 Fig, 16 Ref.

Descriptors: *Benthos, *Lake Geneva, *Switzerland, *Wastewater pollution, *Water pollution effects, Stones, Nutrients, Dreissena, Gammarus, Midges, Trichoptera, Caenis, Tanytarsids, Tubificids, Pisidium, Orthocladiinae, Dugesia, Pentaneurini, Lynaea, Spaerium, Naididae, Asellus, Valvata, Procladius, Psychodidae, Turbidity, Ammonia, Nitrates, Phosphorus.

The influence of the effluent from two small sewage treatment plants (STPs) (3,000 population equivalents) on the stony littoral zone fauna of Lake Geneva was apparent in faunas collected by gathering stones from the bottom. The diversified community of the unaffected area was characterized by Dreissena polymorpha, Gammarus sp., and Chironomids. Numerous other taxa were present. Under the influence of STP outflows, D. polymorpha, Gammarus sp, Hirudinea (2 spp), Trichoptera larvae (6 spp), Caenis horaria, and Tanytarsids exhibited declines; turbidity, NH4, NO3, total P, and total insoluble matter increased around STP outfalls. Groups exhibiting increases in numbers at STP outfalls were Tubificids, Pisidium sp, Orthocladiinae, Chironomids, Dugesia sp, Pentaneurini sp, Lymnaea auricularia, and Sphaerium corneum. Naididae and Asellus aquaticus populations tended to remain unchanged. New members of the fauna near the STPs were Valvata piscinalis, Procladius choreus, and Psychodidae larvae. The effluents cause two main modifications that affect the benthic community: (1) the substratum becomes more homogeneous as insoluble organic matter partially or totally covers the stones, and (2) the wastewater effluents modify the available food by eliminating the epilithic algae, resulting in declines in herbivorous organisms and adaptation by omnivorous invertebrates (L. auricularia, A. aquaticus). (Rochester-IVI)
W86-00949

DIATOM FLORA OF THE LLOBREGAT RIVER AND ITS RELATION TO WATER QUALITY,

Barcelona Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 2H.
W86-00950

MULTILEVEL APPROACH TO THE ASSESSMENT OF ECOTOXICOLOGICAL EFFECTS IN A HEAVY METAL POLLUTED STREAM,

National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
P. J. Sheehan, and A. W. Knight.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2364-2370, 1985. 3 Fig, 3 Tab, 14 Ref.

Descriptors: *Toxicity, *Heavy metals, *Water pollution effects, *Copper, *Zinc, *Little Grizzly Creek, *Plumas County, *California, Fish, Trout, Stoneflies, Mayflies, Caddisflies.

Copper and zinc pollution emanating from an abandoned mine appears to account for the absence of fish and many invertebrates in Little Grizzly Creek, Plumas County, California. No fish were found (by electroshock) in pools at contaminated sites, but populations of rainbow trout and brook trout were abundant in pools above the polluted zone. Stonefly and mayfly nymphs were absent or rare, generally less than 5% of total individuals, and caddisflies made up less than 10% of pooled annual samples, from contaminated sites. The most striking feature of the polluted zone was the overwhelming numerical predominance of chironomid collector-gatherers in invertebrate collections and the rarity of large predatory or omnivorous species. In situ toxicity bioassays showed that summer concentrations of copper at the least contaminated of the affected sites (20-320 micro-g/l Cu) overlap LC50 values for rainbow trout fry within an acute exposure period (about 5-100 hr), a finding which seems to account for the failure of trout to survive in the stream. Stonefly (Doroneuria) nymphs were less sensitive to the mine effluent: 36% mortality was observed in 96 hr at the most contaminated site (1,700 micro-g/l Cu). Evidently other factors than acute toxicity, such as long-term effects or low prey density, account for the absence of Doroneuria in Little Grizzly Creek. Although chironomids dominated numerically at the contaminated sites, fewer genera were present there than in the reference samples. Furthermore, there was a relative absence of < 2 mm size-class individuals, suggesting serious impairment of recruitment at least two of the polluted sites. This effect was confined mainly to the fall season at the third polluted sampling site. (Rochester-IVI)
W86-00953

CHARACTERISTIC DISTRIBUTION OF CHIRONOMIDS IN THE RIVERS POLLUTED WITH HEAVY METALS,

National Inst. for Environmental Studies, Tsukuba (Japan).
M. Yasuno, S. Hatakeyama, and Y. Sugaya.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2371-2377, 1985. 3 Tab, 16 Ref.

Descriptors: *Midges, *Heavy metals, *Bioaccumulation, *Water pollution effects, *Japan, *Yoshino, *Mazawa, *Senasaka, Metals, Cadmium, Copper, Lead, Zinc, Ecological effects, Species composition, Animal tissues.

Chironomids collected in three second-order streams, tributaries of the River Mogami, Yamagata Prefecture, Japan, included three taxa that may be tolerant of heavy metal pollution. The three streams, Yoshino, Mazawa, and Senasaka, receive effluent containing Cd, Cu, Pb, and Zn from abandoned copper mines. A total of 60 species of chironomids were recovered from the three streams. Orthocladiinae had the greatest number of species (35); Chironominae had 15 species. Three species of Orthocladiinae, Eukiefferiella sp A, Orthocladius sp A and Cricotopus sp, were common in all three streams, although the streams are more than 30 km apart. Tolerance of heavy metal pollution appeared to be in the order Eukiefferiella sp A > Orthocladius sp A > Cricotpus sp; none could tolerate the conditions at one station on the River Senasaka, where 1,067 micro-g/l Cu and 2,345 micro-g/l Zn were found in water of pH 4.6. Eukiefferiella sp A, Orthocladius sp A, and Polypedilum sp all accumulated heavy metals in their tissues, although the number of times the river water concentration in their tissues varied by species and by location. For example, Eukiefferiella sp A accumulated Cd 660 times on a dry weight basis; on the other hand, Polypedilum sp, in a pond at pH 2.2, with a copper concentration of 8,498.0 micro-g/l, accumulated far less Cu (24.8 micro-g/g dry weight) than Eukiefferiella sp A (1,816.0 micro-g/g dry weight) in water of much lower concentration (48.4 micro-g/l). The three species of Orthocladiinae were identified as indicators of heavy metal pollution; they may be new species and specific to such environments. The chironomids inhabiting the regions polluted with heavy metals seem to have the ability not to uptake the toxic metals or to excrete them rapidly. (Rochester-IVI)
W86-00954

EFFECTS OF HEAVY METALS ON NITRIFICATION STUDIED WITH CHEMOSTAT TECHNIQUE,

Uppsala Univ. (Sweden). Limnologiska Institutionen.
K.-O. Waara, and A. Wilander.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2378-2382, 1985. 3 Fig, 2 Tab, 12 Ref.

Descriptors: *Heavy metals, *Nitrification, *Chemostats, *Bacteria, Copper, Zinc, Cadmium, Lead, Metals, Growth, Toxicity, Water pollution effects.

Nitrite oxidation by the bacteria of an inoculum from a sewage treatment plant tolerated single metal concentrations high above natural background values at pH 7 in a nitrite-poor medium in chemostats. Copper at 10 micro-g/l induced about a 5% decreased in activity; addition of 25 micro-g/l Cu resulted in a slowly decreasing activity that stabilized at about 50% of the control level. The response to 55 micro-g/l Cu was an immediate 50% inhibition, followed by a gradual increase to 80% inhibition. The effect of 75 micro-g/l Cu was almost total inhibition initially, followed by a recovery from days 6-11, but with inhibition of 90-95% for days 13-19. Inhibition of nitrification with Cd required higher concentrations, as follows: 75 micro-g/l, < 10%, 100 micro-g/l, 25%, 330 micro-g/l 55%, 520 micro-g/l, 85%; 4 mg/l, 90%; and 6 mg/l, 90%. Various concentrations of Pb up to 1 mg/l gave no inhibition of nitrification, but inhibition increased to from 10% to 90% between 1 and 1.7 mg/l, respectively. Zinc addition gave 5% or less inhibition for concentrations through 0.5 mg/l, but inhibition was 10% at 1 mg/l and 80% and 3 mg/l. The order of toxicity was: Cu > Cd > Pb > Zn. (Rochester-IVI)
W86-00955

CR6+ INFLUENCE UPON EPHEMEROPTERA LARVAE IN A PRE-ALPINE TORRENT,

Milan Univ. (Italy). Ist. di Biologia.
M. C. Ramusino, and G. Pacchetti.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2383-2384, 1985. 1 Fig, 3 Ref.

Descriptors: *Aquatic insects, *Chromium, *Larvae, *Alpine regions, *Mountain streams, *Grua, *Agogna, *Borgomanero, *Italy, Toxicity, Water pollution effects, Benthos, Metals, Heavy metals, Streams.

Benthic Ephemeroptera were adversely affected by pollution of an alpine stream (Grua, which flows into the Agogna, near Borgomanero, Italy), and did not recover in the year following installation of a purification plant. Chromium levels were elevated in the stream, with only 3/33 samples having values lower than 0.05 mg/l. Other physical and chemical factors did not seem to be involved in the decrease in the number of Ephemeroptera species that was apparent between upstream, unpolluted stations, and those downstream from the wastewater effluent. Epeorus torrentium, Rhitrogena semicolorata, Habrophlebia umbratilis, and Ecdyonurus helveticus seemed to be most sensitive; Baetis gemellus and B. rhodani were most resistant. Although dissolved Cr(6+) decreased going downstream, the general benthos conditions did not improve, and almost all species underwent a substantial decrease. The patterns of decrease in abundance were similar before and after installation of the purification plant. (Rochester-IVI)

W86-00956

CADMIUM AND CHROMIUM IN THE WATERS, SEDIMENTS AND BIOTA OF THE VAL PARMA RUNNING WATER ECOSYSTEM,
Parma Univ. (Italy). Ist. di Ecologia.
For primary bibliographic entry see Field 5B.
W86-00957

MINE WASTE DISCHARGE RICH IN COPPER - AN EXAMPLE OF EFFECTS ON PLANKTONIC COMMUNITIES,
Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
R. Oliveira, T. Monteiro, C. Cabecadas, C. Vale, and M. J. Brogueira.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2395-2404, 1985. 5 Fig, 5 Tab, 28 Ref.

Descriptors: *Mine drainage, *Copper, *Water pollution effects, *Portugal, *Rabagao River, *Alto Rabagao, *Venda Nova, *Salamonde, *Phytoplankton, *Zooplankton, Sediments, Dissolved oxygen, Nutrients, Metals, Ecological effects.

Examination of the biotic and chemical characteristics of three reservoirs, Alto Rabagao, Venda Nova, and Salamonde, which are in a downstream series on the Rabagao River, north Portugal, suggests that the phytoplankton community has become adapted to high copper concentrations, but that the zooplankton community is adversely affected, particularly at the herbivorous level. Waters of the three reservoirs are well oxygenated, have extremely low alkalinity and hardness, a pH close to neutrality, and are nutrient-poor with a quite low organic content. Mine effluent enters Venda Nova reservoir at its downstream end. Copper in sediments of Venda Nova ranges from 100 to 1,200 ppm, with the highest concentration near the mine effluent source. Concentrations of dissolved copper are also higher in Venda Nova (mean = 390 nanomole (nmol)/kg in the area of high sediment Cu concentration down to 80 nmol/kg away from the mine input) than in Alto Rabagao (mean = 60 nmol/kg) or Salamonde (mean = 70 nmol/kg). A strong reduction in plankton species per sample and in density was observed in the area of Venda Nova where Cu in water and sediments was high; a shift in community composition was evident to one dominated by Cosmarium tinctum, Keratella valga, and Tropocyclops prasinus. Cosmarium tinctum dominated in the unpolluted parts of this reservoir as well, whereas replacement of Ceriodaphnia quadrangula and Keratella cochlearis by K. valga occurred under the highest contamination. The effects of contamination by copper were apparent in data on percentage similarity and coefficient of community, but the Shannon-Wiener diversity index was sensitive for zooplankton only. (Rochester-IVI)
W86-00959

CADMIUM PARTITIONING AND RELATED EFFECTS IN PARASITIZED AND NON-PARASITIZED MOSQUITOFISH (GAMBUSIA AFFINIS: POECILIIDAE),
Michigan State Univ., East Lansing. Pesticide Research Center.
J. P. Giesy, and D. H. Smith.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2405-2412, 1985. 1 Fig, 4 Tab, 27 Ref.

Descriptors: *Fish physiology, *Mosquitofish, *Cadmium, *Parasites, *Toxicity, Animal physiology, Water pollution effects, Metals, Heavy metals, Liver, Embryos, Bioaccumulation.

Interactions of low-level cadmium exposure and parasitization completely blocked reproduction in mosquito fish in what appeared to be a synergistic manner. Fish embryos were observed only in non-parasitized individuals among those exposed to Cd. Non-parasitized mosquitofish and mosquitofish parasitized with metacercaria of Diplostomulum scheuringi (Trematoda: Strigeidae) were exposed for 55 days to 0.02, 2.3, 3.1, 5.6, and 7.5 micro-g Cd/l added as CdCl2 in a continuous flow system. Cadmium accumulation by whole fish and fish livers was proportional to water Cd concentration. Mean whole fish and fish liver Cd concentrations across treatments ranged from 1.0-4.1 and 15.6-24.0 micro-g/g dry weight, respectively. Cadmium accumulation by fish was not affected by parasite burden. Cadmium concentrations in embryos were directly proportional to Cd content of whole fish, fish livers, and water. Parasite numbers were proportional to fish size and were not affected by Cd concentrations in water and fish, but mean parasite weight was inversely proportional to fish whole body Cd concentrations. No Cd- or parasite-induced effects on mortality or growth were observed. Mean recoverable liver weight was negatively related to both whole fish and liver Cd concentrations. (Rochester-IVI)
W86-00960

DRIFT RESPONSE OF AQUATIC INSECTS TO COPPER,
Geological Survey, Menlo Park, CA.
H. V. Leland.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2413-2419, 1985. 1 Fig, 1 Tab, 16 Ref.

Descriptors: *Aquatic drift, *Aquatic insects, *Copper, *Metals, *Water pollution effects, *Convict Creek, *California, Animal behavior, Mayflies, Caddisflies, Behavior, Species composition.

Different responses to continuous copper dosing were observed among drift insects in a section of the oligotrophic Convict Creek, California. Convict Creek, which has a pH in the range 7.9-8.5, and is always at or near saturation with dissolved oxygen, received copper continuously at rates of either 2.5, 7, 15 micro-g/l (approx 12, 35, and 75 nanogram/l Cu(2+)). Declines in population densities of common Ephemeroptera coincident with initial increases in drift density were evident in stream sections dosed with 7 and 15 micro-g/l total Cu. Population densities of many common aquatic Diptera (Antocha monticola, Hexatoma spp, Simulium spp, and Chironomidae) also declined at these doses, but drift densities of these taxa did not increase appreciably at these concentrations. Adults of the common Coleopterans Optioservus divergens and Cleptelmis addenda showed an increased propensity for drift at 15 micro-g/l total Cu, but neither species declined in the benthos, suggesting that Elmidae respond to sublethal copper concentrations by an increase in activity. Common insect taxa in the benthos and the drift were identified. Many were nocturnal, with the mayfly Baetis spp numerically dominant in the post-dusk drift. The caddisfly Brachycentrus americans was the only common drifting aquatic insect that was clearly more active during the day than at night. Drift densities of most of the common aquatic insects exhibited a consistent diel periodicity even in the presence of added copper. Drift densities were highest during periods when foraging normally occurred. (Rochester-IVI)
W86-00961

USE OF AQUATIC BRYOPHYTES TO MONITOR HEAVY METALS POLLUTION OF FRESHWATERS AS ILLUSTRATED BY CASE STUDIES,
Metz Univ. (France). Lab. d'Ecologie.
For primary bibliographic entry see Field 7B.
W86-00962

EFFECTS OF ACUTE PARATHION POLLUTION ON MACROINVERTEBRATES IN A STREAM,
Parma Univ. (Italy). Ist. di Ecologia.
P. F. Ghetti, and G. Gorbi.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2426-2431, 1985. 1 Fig, 3 Tab, 8 Ref.

Descriptors: *Parathion, *Insecticides, *Water pollution effects, *Macroinvertebrates, Aquatic drift, Species composition, Ecological effects, Toxicity.

Parathion, when added to an experimental stream in a manner simulating an accidental spill, produced rapid catastrophic mortality in stream insects; this impact was reflected in the rate and composition of drift, thus demonstrating that drift collections provide a way to reveal both the direct lethal effect and the successive recolonization and stabilization process of the community. An acute pollution event lasting 6 hr was produced by achieving a concentration of 1 + or - 0.18 mg/l parathion in a reach of stream in which drift in and out of the reach was monitored and substrates above and within the reach were sampled. The choice of concentration and duration was based on initial toxicity experiments which showed LC50s as follows: Brachidanio rerio (Pisces), 5.64 mg/l, Biomphalaria glabrata (Gastropoda), 8.09 mg/l; and Daphnia magna, 0.004 mg/l; and LT50s as follows: Echinogammarus stammeri, 92 min; Hydropsyche pellucidula, 110 min; and Baetis rhodani, 65 min. After the 6 hr dosing of the experimental stream, 100% of the Plecoptera, 78% of the Diptera, and 30% of the Trichoptera and Amphipoda had died on the first series of substrates, which were less than 100 m downsteam from where the parathion was introduced. By 24 hr after parathion release, 100% of the Diptera, 90% of the Amphipoda, 61% of the Trichoptera, 25% of the Isopoda, and 37% of the Coleoptera had died. At the substrates about 200 m below the release point, mortality continued after 24 hr, reaching 100% of the Trichoptera, Amphipoda, and Isopoda and 50% of the Coleoptera after 7 days. No mortality was observed in Mollusca and Oligochaeta species. Recolonization observed 30 days after the experiment resulted in a community of significantly different structure than the one present at the upstream station at the same time, suggesting a continuing, medium-term effect of pesticide release on the recolonization process. (Rochester-IVI)
W86-00963

USE OF LIMNOCORRALS FOR PESTICIDE TOXICITY STUDIES: EFFECT ON ZOOPLANKTON COMPOSITION AND DYNAMICS,
Tel-Aviv Univ. (Israel). Inst. for Nature Preservation Research.
For primary bibliographic entry see Field 5A.
W86-00964

EFFECTS OF 2,4-D ON NATURAL PHYTOPLANKTON SYSTEMS IN ASSOCIATION WITH MYRIOPHYLLUM SPICATUM,
National Water Research Inst., Burlington (Ontario).
B. F. Scott, N. D. Dickman, and P. Hayes.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2437-2446, March, 1985.

Descriptors: *Phytoplankton, *Myriophyllum, *Pesticides, *2,4-D, Herbicides, Organic compounds, Sediments, Macrophytes, Dissolved oxygen, Water pollution effects, Fate of pollutants, Food chains, Algae.

To investigate all aspects of an aquatic ecosystem and to follow the fate of added chemicals, as well as the breakdown products, a series of polyethylene-lined ponds were constructed. The linings of these ponds were covered with sediment and Myriophyllum spicatum plants were implanted in this sediment. Each major component of the food web was analyzed and interactions between the components were compiled. Specifically in this report, the chemistry of the 2,4-D and 2,4-DCP as well as the phytoplankton population fluctuations in association with the macrophyte, M. spicatum, for the 1981 tests is presented. The populations of dominant algal species in the treated ponds were corrected by subtracting the appropriate populations found in the control ponds. Species whose populations increased after treatment include Scenedesmus incrassatulus and Oscillatoria limnetica with other species having slight enhancements. Oocystis eremosphaeria and Cosmarium cf. punctatum exhibited inhibition after treatment but soon recovered. By examining all components of the food web in lined-pond ecosystems, the fate and impact of suspected toxic substances can be determined under natural environmental conditions. (Baker-IVI)
W86-00965

STRUGGLE AGAINST ONCHOCERCIASIS IN THE VOLTA REGION: IMPACT OF INSECTICIDE TREATMENT ON THE NON-TARGET AQUATIC FAUNA (LA LUTTE CONTRE L'ONCHOCERCOSE DANS LA REGION DES VOLTA: IMPACT DES TRAITEMENTS INSECTICIDES SUR LA FAUNE AQUATIQUE NON-CIBLE),
Laboratoire d'Ichtyologie Generale et Appliquee, Paris (France).
D. Paugy.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, Part 4, p 2447-2451, March 1985. 10 Ref.

Descriptors: *Water pollution effects, *Insecticides, *Aquatic animals, *Africa, *Onchocerciasis, Vector control, Fish, Invertebrates, Fish food, Public health, Temephos, Chlorphoxime, Bacillus thuringiensis, Toxicity, Rivers.

Since 1974, a campaign to interrupt transmission of the parasitic disease onchoceriasis in 7 states in western Africa has included the regular application of biodegradable insecticides to eliminate the aquatic larval phase of the insect vector. The insecticides used were temephos, chlorphoxime and the biological insecticide Bacillus thuringiensis. Surveillance of the fish populations and aquatic invertebrates was carried out for 8 years to determine the effects of the insecticide treatment. The treatment of rivers has not brought about a perturbation in the fish populations. There was an effect on the lotic invertebrates, but it was at acceptable levels with all of the insecticides studied. As long as the fish do not suffer serious effects from the reduction in the numbers of invertebrate food species or the absence of some species, the human health concerns will outweigh the effects on the aquatic fauna. (Moore-IVI)
W86-00966

INFLUENCE OF PESTICIDES IN THE POLLUTION OF CONTINENTAL AFRICAN WATERS (INCIDENCE DES PESTICIDES DANS LA POLLUTION DES EAUX CONTINENTALES AFRICAINES),
Office de la Recherche Scientifique et Technique Outre-Mer, La Teste (France).
C. Dejoux.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, Part 4, p 2452-2456, March, 1985. 10 Ref.

Descriptors: *Pesticides, *Africa, *Water pollution effects, Agricultural chemicals, Vector control, Aquatic animals, Invertebrates, Water quality, Fish, Water pollution control.

The efforts to control major epidemic diseases in Africa necessitate the frequent introduction of pesticides into the aquatic environment or their use in the immediate area. The use of pesticides in agriculture is also very great. The effects of pesticides on the fauna of aquatic ecosystems in Africa was reviewed. Long-term, increasing effects including reduction in water quality and massive deaths of invertebrates can result from badly-used pesticides; this in turn can lead to the reduction of fish stocks. The same effect may result from pesticides which are directly toxic to fish. When pesticides are used on a large scale, whether temporal or spatial, strict control is necessary. In spatially broad pesticide programs, a permanent collaboration between users and environmental scientists may be necessary to forsee the impact. Monitoring is essential in such circumstances. (Moore-IVI)
W86-00967

MODEL FOR FORECASTING ACUTE TOXICITY OF RIVER WATER FOR FISH (MODELE DE PREVISION DE LA TOXICITE AIGUE DES EAUX DE RIVIERES POUR LE POISSON),
Metz Univ. (France). Faculte des Sciences.
J. C. Pihan, and G. Landragin.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2457-2462, 1985. 11 Fig, 1 Tab, 7 Ref.

Descriptors: *Model studies, *Toxicity, *Fish, *Forecasting, Ammonia, Nitrates, Cyanide, Phenols, Heavy metals, Detergents, Potassium, Sodium.

A 'concentration and addition type' model uses the CL50-48h proportions addition method, in order to assess a global index of toxicity. This model takes into account the following parameters: NH4, NO2, CN, phenols, Zn, Cu, Pb, Cd, Ni, K, Na, anionic detergents, As, Se, Cr, Mn, calculated in water. It calculates the CL50-48h of these toxicants according to environmental parameters in each sample. A statistical and graphic interpretation of the results enables one to give a qualitative and quantitative judgment of the toxicity level of a river, and the safety measures to observe. This model also allows one to test a future scenario for the river. (Author's abstract)
W86-00968

ACCUMULATION OF RADIUM-226 BY POPULATIONS OF THE FRESHWATER MUSSEL, VELESUNIO ANGASI, FROM THE ALLIGATOR RIVERS URANIUM PROVINCE, NORTHERN TERRITORY, AUSTRALIA,
Australian Atomic Energy Commission Research Establishment, Sutherland.
R. A. Jeffree.
Verhandlung Internationale Vereinigung Limnologie, Vol. 2, No. 4, p 2486-2492, March, 1985. 3 Fig, 2 Tab, 10 Ref.

Descriptors: *Radium radioisotopes, *Mussels, *Alligator Rivers Uranium Province, *Northern Territory, Australia, Billabongs, Calcium, Magnesium, Uranium mines.

The radionuclide Ra-226 naturally leaches from uranium deposits in the Alligator Rivers Uranium Province, Northern Territory. Mussels sampled from Corndorl, Georgetown and Mudginberri Billabongs individually vary over an order of magnitude in their Ra-226 tissue concentration. Because of this variability, large actual increases in the tissue concentration of Ra-226 above these levels would have to occur before a statistically significant increase could be demonstrated. The predictive relationships established between Ra-226 concentration and size measurements, and Ca and Mg concentration can be used to reduce this variance. For each billabong, these regression equations can be used to account for between 83 and 97% of the variance in Ra-226 concentration. For mussels from the three billabongs, the significant predictors of Ra-226 concentration show similar relationships. The concentration of Mg, in combination with size measurements, is a significant predictor of Ra-226 in mussels from Georgetown and Mudginberri billabongs. Because predictive relationships can be population specific, they would need to be separately determined for each billabong from which mussels were harvested for human consumption, and which could potentially receive uranium mine effluent or were to be used as a control sampling site. The pattern of accumulation of Ra-226 indicates that V. angasi does not regulate its concentration of Ra-226, but continues to accumulate Ra-226, and also Ca, as it increases in size. The accumulated Ra-226 is located predominantly together with Ca and Mg in granular deposits that are dispersed throughout the tissues, and that increase in abundance with increasing mussel size. (Baker-IVI)
W86-00972

EFFECTS OF POWER PLANT ENTRAINMENT ON PHYTOPLANKTON RESPONSE,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
W. Y. B. Chang, and R. Rossmann.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2493-2497, March, 1985. 2 Fig, 1 Tab, 5 Ref.

Descriptors: *Phytoplankton, *Powerplants, *Entrainment, *Thermal pollution, Water pollution effects, Chlorophyll, Phaeophytin, Primary productivity, Cooling water, Heated water, Corrosion.

The effect of entrainment on phytoplankton has been investigated using chlorophyll and cell counting techniques alone from 1975 to 1979 and in conjunction with C-14 uptake methods since 1979. Chlorophyll and phaeophytin concentrations as well as cell counts do not significantly change in water which has passed through the condenser cooling system; productivity is reduced significantly (20-80%). Between 1980 and 1982, the relationship of this reduction to temperature, hydromechanics, and availability of micronutrients was investigated. Elevated temperature experiments showed that the rate of reduction in primary productivity was greatest in those samples subjected to heat above 35 degrees C. For the samples heated to or above 50 C, the primary productivity after 24 hours of incubation was less than 0.5 mg/cu m and was at times close to zero. The productivity samples from the intake water which had been raised to the temperature of the discharge water had productivities as high as those of intake samples. This suggests that although water is well mixed after going through the condenser cooling system, the water passing through the condenser itself receives a differential heat, such that a portion of the lake water was heated above the tolerance level for phytoplankton. Fragments of phytoplankton did not increase significantly after the water passed through the system, and pigment concentration showed no significant difference before and after passage through the condenser cooling system. Differential temperature effects on the water passing through the cooling system is a source of the reduction in primary productivity at the particular power plant, but EDTA experiments lead to the conclusion that the presence of microelements can also be a factor in producing this change. Thus, the effects of corrosion of plant components cannot be excluded entirely from the assessment. (Baker-IVI)
W86-00973

MUTAGENICITY AND ORGANIC HALOGEN DETERMINATION IN BODY FLUIDS AND TISSUES OF RATS TREATED WITH DRINKING WATER AND PULP MILL BLEACHERY EFFLUENT CONCENTRATES,
Sentralinstitutt for Industriell Forskning, Oslo (Norway).
S. Monarca, J. K. Hongslo, A. Kringstad, and G. E. Carlberg.
Chemosphere, Vol. 13, No. 12, p 1271-1281, 1984. 5 Tab, 31 Ref.

Descriptors: *Halogenated hydrocarbons, *Mutagens, *Drinking water, *Bleaching wastes, Pulp wastes, Chlorination, Toxicity, Water pollution effects, Bioassay,.

The use of chlorine for drinking water disinfection and as a bleaching agent in the pulp and paper industry produces mutagenic compounds in drinking water and spent bleach liquors. Urine, feces, liver and adipose tissues of rats after treatment with single doses of concentrates of either a drinking water or pulp mill effluent were tested for mutagenic activity using the microscale fluctuation assay, a sensitive bacterial mutagenicity test. Similar organic halogen doses were administered. Urine, feces, liver, and adipose tissues were also analyzed for organic halogen. For both samples types nearly all the organic halogen taken up (18% from the chlorination stage sample and 4% from the drinking water sample) was excreted via the urine during the first day. The difference in uptake of organic halogen between the two samples can probably be explained by difference in size and polarity distribution of the halogenated compounds. Weak mutagenic activity could be found in the urine collected the first day from animals treated with the highest dose of drinking water. No mutagenic activity was detected in the urine from animals treated with the pulp mill concentrates, or in the feces or tissue extracts from the two treatment groups. (Moore-IVI)
W86-00993

FATE AND EFFECTS OF PENTACHLOROPHENOL IN HARD- AND SOFT-WATER MICROCOSMS,
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W86-00998

'MAN AND THE BIOSPHERE' - STUDIES ON SIKKIM HIMALAYAS. PART 1: ACUTE TOXICITY OF COPPER AND ZINC TO COMMON

CARP CYPRINUS CARPIO (LINN.) IN SOFT WATER,
Delhi Univ. (India). Dept. of Anthropology.
B. S. Khangarot, A. Sehgal, and M. K. Bhasin.
Acta Hydrochimica et Hydrobiologica, Vol. 11, No. 6, p 667-673, 1983. 1 Fig, 4 Tab, 21 Ref.

Descriptors: *Carp, *Toxicity, *Copper, *Zinc, Hardness, Mortality, Heavy metals, Fish.

The effects of Cu and Zn on the common carp (Cyprinus carpio) were studied in soft water (7.1 mg/l Ca(2+) and 0.7 mg/l Mg(2+)) at water temperatures of 11 to 14 C. The survival rate of fish decreased as the concentration of Cu and Zn increased. Most of the mortality appeared in the first 48 hr of exposure. No mortality was observed in carp exposed to Zn or Cu concentrations of 0.1 ppm and 0.005 ppm, respectively. The 96-hr LC50 for Cyprinus carpio was observed to be 0.063 mg/l Cu(2+) and 3.12 mg/l Zn(2+). Significant differences in mortality in relation to the 12-hr LC50 occur for copper only after 72 hr of exposure and for zinc after 48 hr of exposure. The values of 96-hr LC50 are clearly lower for both metals in these investigations than most values given in the literature for other fish species. (Moore-IVI)
W86-01003

ZINC INDUCED LESIONS IN THE GILLS OF RASBORA DANICONIUS NEILGERIENSIS (HAMILTON),
Delhi Univ. (India). Dept. of Anthropology.
B. S. Khangarot.
Acta Hydrochimica et Hydrobiologica, Vol. 11, No. 6, p 675-682, 1983. 7 Ref.

Descriptors: *Zinc, *Fish, *Gills, *Water pollution effects, Toxicity, Heavy metals, Histology.

Structural changes in the gills of a freshwater teleost, Rasbora daniconius neilgeriensis following exposure to zinc were examined. The most notable sign of induced gill damage was the detachment of the outer layer of secondary lamellae and necrosis of the epitheial sheet. Histological changes suggest that zinc has a direct effect on the branchial apparatus which may result in a gradual decline of the oxygen carrying capacity and hence cause anoxia culminating in respiratory failure. This increasing anoxic state may also have deterimental effects on other sensitive tissues such as the central nervous system and the cardiac and muscular systems. (Baker-IVI)
W86-01004

WATER QUALITY CONTROL IN IMPOUNDMENTS,
Institut Hygieny a Epidemiologie, Prague (Czechoslovakia).
For primary bibliographic entry see Field 5G.
W86-01006

INFLUENCE OF ZINC AND LEAD COMPOUNDS IN WATER ON THE ASSIMILATION OF FONTINALIS ANTIPYRETICA (ZUM EINFLUSS VON RUCKSTANDEN VON ZINK- UND BLEIVERBINDUNGEN IM WASSER AUF DIE ASSIMILATION VON FONTINALIS ANTIPYRETICA),
Technische Univ., Dresden (German D.R.). Sektion Wasserwesen.
G. Weise, G. Burger, S. Fuchs, and L. Schurmann.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 25-34, 1985. 5 Fig, 20 Ref.

Descriptors: *Lead, *Zinc, *Fontinalis, *Carbon dioxide, Aquatic plants, Heavy metals, Phytotoxicity, Photosynthesis, Light effects, Plant physiology, Water pollution effects.

The carbon-dioxide assimilation of Fontinalis antipyretica is inhibited by 100 mg/l Zn(2+) or Pb(2+), without a lethal effect being caused. With increasing time of exposure from one to six days the threshold value of toxicity is lowered and at the same time the net assimilation is reduced within the range of concentration of 0.1 mg/l. In the ecological optimum of the environmental conditions the toxicity is weaker than under other unfavorable environmental conditions at the same time. Therefore, the photoecologically optimum illumination of 1200 lx is an effective bioprotector against phytotoxic lead ion concentrations, so that at 1200 lx also at a comparatively high load a positive photosynthesis balance can be maintained. In the dark, in the first hour after the application of the lead ions dissimilation is a function of concentration, subsequently the respiration differences decrease very much in the range between 0 and 100 mg/l lead(II)-ions. Stimulating effects could be demonstrated only by 0.01 mg/l Pb(2+) and only for the carbon dioxide assimilation. (Author's abstract)
W86-01008

ACUTE TOXICITY OF DISTILLERY EFFLUENT ON A FRESHWATER FISH AND THREE POND SNAILS,
Udaipur Univ. (India). Dept. of Limnology and Fisheries.
B. S. Khangarot, P. S. Rao, S. S. Shekhawat, and V. S. Durve.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 53-58, 1985. 3 Tab, 21 Ref.

Descriptors: *Toxicity, *Fish, *Snails, *Distillery wastes, Industrial wastewater, Effluents, Water pollution effects, Bioassay, Sulfides, Suspended solids.

The LC50 for 12-96 h of a distillery wastewater were determined for Lebistes reticulatus, Lymnaea luteola, Lymnaea acuminata and Viviparus bengalensis in the batch experiment with daily exchange of the medium. The sensitivity of the species increases in the given sequence with values of the LC50,96h of 10.77 to 3.73% proportion of wastewater in the medium. Compared with this, with values of the LC50,48h of 14.06-15.71% after 48 h of exposure there is no significant difference in sensitivity, whereas after exposure for 12 and 24 h the sensitivity grows in the following order: V. bengalensis, L. acuminata, L. luteola, Lebistes reticulatus. Toxicity is obviously primarily determined by the sulfides; with increasing time of exposure also the suspended matter and other factors act toxically. (Author's abstract)
W86-01011

ABSENCE OF SELENATE AVOIDANCE BY FATHEAD MINNOWS (PIMEPHALES PROMELAS),
North Texas State Univ., Denton. Dept. of Biological Sciences.
D. E. Watenpaugh, and T. L. Beitinger.
Water Research, Vol. 19, No. 7, p 923-926, 1985. 1 Fig, 2 Tab, 30 Ref.

Descriptors: *Selenates, *Fathead minnows, *Avoidance, Fish behavior, Selenium, Water pollution effects.

Forty fathead minnows (Pimephales promelas) were individually offered a choice between 'clean' water and water containing selenate in a flow-through, Sprague-type avoidance system. During a control period beginning each trial, fatheads exhibited no significant avoidance of either end of the test chamber. Mean residence times in the two ends equalled 48.8 and 51.2% of total time. Similarly fathead minnows did not avoid selenate at concentrations of 0.3-11.2 mg Se/l in 4 separate trials. Overall, the 40 fish partitioned 48.5 and 51.5% of their time in the selenate and selenate-free ends respectively. These results demonstrate that fathead minnows do not behaviorally avoid harmful concentrations of selenate. (Author's abstract)
W86-01067

SOME OBSERVATIONS ON THE OXYGEN CHANGES IN A LAKE COVERED WITH PISTIA STRATIOTES L.,
Ibadan Univ. (Nigeria). Dept. of Preventive and Social Medicine.
M. K. C. Sridhar, and B. M. Sharma.
Water Research, Vol. 19, No. 7, p 935-939, 1985. 1 Fig, 7 Tab, 19 Ref.

Descriptors: *Water lettuce, *Dissolved oxygen, *Lakes, Eutrophication, Nutrients, Water pollution effects, Hydrogen ion concentration, Aquatic plants, Decomposition.

Water lettuce (Pistia stratiotes) is a common free floating aquatic weed in most of the water bodies in Nigeria. In Oba, the lake under study, this weed at one time covered the whole surface. A bamboo barrier was put across the lake and the weed was removed manually from one zone. The lake is fed by two major streams, one of which is polluted and rich in nutrients. A study was made on the dissolved oxygen levels and pH changes in the lake. The lake generally showed low levels of dissolved oxygen and low pH values. These could be attributed to the incoming organically rich water, coverage of the surface by Pistia plants and to the decomposition of these plants resulting in the formation of sludge at the bottom of the lake. Only on one occasion during rainy season did the dissolved oxygen exceed the natural saturation level. That was probably as a result of algae being washed in. (Moore-IVI)
W86-01068

ASSESSMENT OF ECOLOGICAL CHANGES DURING THE RECENT HISTORY OF LAKE ONTARIO BASED ON SILICEOUS ALGAL MICROFOSSILS PRESERVED IN THE SEDIMENTS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 2H.
W86-01110

RESPONSES OF BENTHIC MEIOFAUNA TO LONG-TERM, LOW-LEVEL ADDITIONS OF NO. 2 FUEL OIL,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
J. B. Frithsen, R. Elmgren, and D. T. Rudnick.
Marine Ecology - Progress Series, Vol. 23, No. 1, p 1-14, 1985. 5 Fig, 3 Tab, 99 Ref.

Descriptors: *Hydrocarbons, *Fuel oil, *Water pollution effects, Ecological effects, Sediments, Fate of pollutants, Benthos.

Three experiments were conducted to investigate the responses of benthic meiofauna to long-term, low-level additions of No. 2 fuel oil in large (13 cu m), outdoor tanks (mesocosms) containing sediment and sea water from Narragansett Bay, Rhode Island. In the first experiment, an average water column oil concentration of 190 ppb was maintained for 168 d followed by a 64 d period of no oil additions. During the second experiment, an average oil concentration of 90 ppb was maintained for 122 d. A 386 d period of no oil additions (Experiment III) followed Experiment II. The abundances of metazoan meiofauna decreased during oil addition periods in Experiments I and II with the oil more extensively affecting the meiofauna in the first experiment. In both experiments, ostracods and harpacticoid copepods were the most sensitive metazoan groups. In contrast, abundances of protozoan meiofauna (foraminiferans and ciliates) were higher in the oiled mesocosms. Abundances of most meiofaunal groups returned to levels similar to the controls within 2 to 7 mo following the termination of oil additions. However, the abundances of kinorhynchs and halacarids remained depressed for more than 1 yr after the last oil addition, presumably due to residual oil in the sediments. (Author's abstract)
W86-01124

QUALITATIVE ANALYSIS OF THE PELAGIC FOODWEBS OF THREE ACID-IMPACTED LAKES IN NOVA SCOTIA, CANADA,
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W86-01129

EFFECTS OF ENTRAINMENT ON PHYTOPLANKTON PRIMARY PRODUCTION AT FOUR THERMAL ELECTRIC GENERATING

STATIONS ON THE LAURENTIAN GREAT LAKES,
Ontario Hydro, Toronto. Research Div.
T. G. Dunstall.
Internationale Revue der Gesamten Hydrobiologie, Vol. 70, No. 2, p 247-257, 1985. 3 Fig, 3 Tab, 31 Ref.

Descriptors: *Environmental effects, *Electric power production, *Great lakes, *Phytoplankton, *Entrainment, *Laurentian Great Lakes, Cooling water, Primary production, Water temperature, Water pollution effects, Thermal pollution.

Primary production was used to measure the response of phytoplankton to entrainment in once-through cooling water at thermal electric generating stations. Ambient lakewater temperatures ranged from 1.0 to 20.5 C. The maximum discharge temperature was 32.0 C. There was no chlorination of cooling water at the stations studied. On a few occasions, primary production was stimulated following station passage by discharge temperatures which were approximately 10 C above ambient lakewater temperatures of 4.5 to 8.5 C. Differences in production levels were not apparent, however, following the return of discharge water to ambient lakewater temperature. There was no consistent response of phytoplankton to the temperature regimes tested, with production levels generally differing by less than 20% as a result of station passage or temperature elevation alone. Entrainment was considered to have minimal impact on phytoplankton productivity in large open water bodies such as the Great Lakes. (Author's abstract)
W86-01132

EFFECTS OF BENTHIOCARB HERBICIDE ON GROWTH OF PLANKTONIC ORGANISMS, CHLORELLA SACCHAROPHILA AND BRACHIONUS PLICATILIS,
Kagoshima Univ. (Japan). Faculty of Fisheries.
H. Hirata, S. Yamasaki, and E. Kohirata.
Memoirs of the Faculty of Fisheries, Kagoshima University, Vol. 33, No. 1, p 51-56, December, 1984. 3 Fig, 3 Tab, 9 Ref.

Descriptors: *Herbicides, *Benthiocarb, *Toxicity, *Growth, *Chlorella, *Brachionus, Water pollution effects, Ethanol, Pesticides, Zooplankton, Phytoplankton.

The effects of benthiocarb herbicide on the population growth of planktonic organisms were examined to evaluate its toxicity in natural rivers as runoff from rice fields. The organisms used in this experiment were Chlorella saccharophila and Brachionus plicatilis. Concentrations of the herbicide were regulated to sub-acute levels at: 0.0 ppm as control, 0.0003 ppm, 0.01 ppm, 0.03 ppm, 0.1 ppm, and 0.3 ppm. Ethanol was used to dilute the original concentrated benthiocarb. The effects of ethanol on the growth of plankton were also observed. There were no significant differences found among the culture experiments conducted for the growth of C. saccharophila and B. plicatilis below the herbicide concentration of 0.3 ppm. However, in the ethanol experiments, the growth rate of plankton was less than that at a 0.3 ppm herbicide concentration. Careful utilization of ethanol for dilution is suggested for practical use. (Author's abstract)
W86-01146

TOXICITY CURVE ESTIMATION: FITTING A COMPARTMENT MODEL TO MEDIAN SURVIVAL TIMES,
Ortho Pharmaceutical Corp., Raritan, NJ. Dept. of Medical Biostatistics.
R. D. Chew, and M. A. Hamilton.
Transactions of the American Fisheries Society, Vol. 114, No. 3, p 403-412, May, 1985. 6 Fig, 1 Tab, 24 Ref.

Descriptors: *Toxicity curves, *Compartment models, *Toxicology, *Median survival times, Mathematical analysis, Statistical analysis, Data interpretation.

In an acute lethality toxicity test, organisms are continuously exposed to each of several concentrations of the toxicant and subsequent deaths are recorded. The results of the test are often summarized by the toxicity curve, which shows for each concentration the exposure time required to cause exactly 50% mortality. A new statistical procedure for estimating the toxicity curve was developed; it is based on a mathematical model derived from plausible assumptions about the biological mechanisms of acute toxicity. The statistical fit of the model is accomplished by nonlinear, weighted, least-squares regression, estimated median survival times being responses and concentration being the independent variable. The usual methods for constructing a toxicity curve are encumbered by at least one of two weaknesses: either the mathematical form of the curve has no apparent biological justification or the statistical fit of the curve treats concentration as the response and time as the independent variable, thereby reversing the cause-effect relationship. The new method possesses neither of these deficiencies. Analyses of two toxicity tests indicate that the proposed mathematical model is not inconsistent with real data. (Author's abstract)
W86-01152

EFFECTS OF SUBLETHAL COPPER CONCENTRATIONS ON THE STRUCTURE AND ACTIVITY OF ATLANTIC SILVERSIDE SCHOOLS,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
K. H. Koltes.
Transactions of the American Fisheries Society, Vol. 114, No. 3, p 413-422, May, 1985. 8 Fig, 2 Tab, 46 Ref.

Descriptors: *Copper, *Toxicity, *Water pollution effects, *Silverside, *Fish behavior, Behavior, Metals, Animal behavior.

The effects of sublethal concentrations of copper on the structure and activity of schools of the Atlantic silverside, Menidia menidia, were studied. A computerized video technique was employed to provide three-dimensional analysis. Ten experiments were conducted in which the behavior of a school exposed to from 0 to approximately 100 micro-g/L of copper was compared to the behavior of the same school on the previous day (control). Fish schools exposed to copper differed significantly ($P < 0.05$) from control schools in distance to nearest neighbor, swimming speed, mean direction of travel, rate of change of direction, and depth of the school in the tank. At low concentrations of copper, schools increased their swimming speed, decreased their rate of change of direction and their nearest-neighbor distances, and swam more in parallel orientation than schools under control conditions. (Author's abstract)
W86-01153

PLASMA OSMOTIC AND ELECTROLYTE CONCENTRATIONS OF LARGEMOUTH BASS FROM SOME ACIDIC FLORIDA LAKES,
Florida Univ., Gainesville. Dept. of Fisheries and Aquaculture.
D. E. Canfield, Jr., M. J. Maceina, F. G. Nordlie, and J. V. Shireman.
Transactions of the American Fisheries Society, Vol. 114, No. 3, p 423-429, May, 1985. 3 Tab, 29 Ref.

Descriptors: *Fish physiology, *Bass, *Hydrogen ion concentration, *Florida, Acidity, Acid lakes, Growth, Water pollution effects.

Five acidic clear (pH 3.7-4.9), three acidic colored (pH 4.1-4.6), and three neutral (pH 6.9-7.3) north-central Florida lakes were surveyed in 1983 to determine plasma osmotic and electrolyte concentrations, growth, and coefficients of condition for largemouth bass, Micropterus salmoides floridanus. Plasma osmotic concentrations averaged greater than 273 milli-osmoles/kg in fish from acidic colored and circumneutral lakes, but averaged less than 269 milli-osmoles/kg in four of the acidic clear lakes. Growth and coefficients of condition of largemouth bass > 305 mm total length in the acidic lakes were significantly lower than in the neutral lakes. Reduction in fish growth and condition, however, could be related to either acidic conditions or lake trophic status. (Author's abstract)
W86-01154

CHANGES IN THE PLEUSTIC MACROPHYTE FLORA OF 54 SMALL FINNISH LAKES IN 30 YEARS,
Helsinki Univ. (Finland). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W86-01156

GROWTH AND FEEDING BEHAVIOUR RESPONSES OF LARGEMOUTH BASS (MICROPTERUS SALMOIDES) EXPOSED TO PCP,
Queen's Univ., Kingston (Ontario). Dept. of Biology.
R. A. Mathers, J. A. Brown, and P. H. Johansen.
Aquatic Toxicology, Vol. 6, No. 3, p 157-164, May, 1985. 2 Tab, 16 Ref.

Descriptors: *Bass, *Growth, *Fish physiology, *Fish behavior, *Pentachlorophenol, Water pollution effects, Chlorinated hydrocarbons, Animal behavior, Toxicity.

Previous experiments have shown that chronic exposure to PCP results in a reduction in fish growth. The effects of PCP on growth reponse have not been examined for any of the Centrarchid family which includes the largemouth bass (Micropterus salmoides). The growth and feeding behavior of individually held underyearling largemouth bass exposed to 50 micro-g/l pentachlorophenol (PCP) was monitored over a 7-day period which followed a 7-day acclimation period to the experimental conditions. Exposure to PCP reduced food conversion efficiency (g of growth/g of food) by 30% as well as the amount of food consumed. Feeding efficiency (capture to strike ratio) was also lowered by PCP exposure. No PCP could be detected in the fish not exposed to PCP. Of the fish exposed to PCP there was no significant difference between the concentrations found in the high ration fish (mean = 10.8 micro-g PCP/g, SD = 1.4, n = 4) and the low ration fish (mean = 9.6 micro-g/g, SD = 4.7, n = 5). PCP not only puts a physiological stress on fish but it also induces changes in feeding behavior. The experiment not only documents growth related responses to a toxic substance but demonstrates that the effects of a toxic substance can be readily determined with a carefully executed short term experiment. (Collier-IVI)
W86-01157

CYTOTOXICITY/GENOTOXICITY: THE APPLICATION OF CELL CULTURE TECHNIQUES TO THE MEASUREMENT OF MARINE SEDIMENT POLLUTION,
Washington Univ., Seattle. Coll. of Forest Resources.
R. M. Kocan, K. M. Sabo, and M. L. Landolt.
Aquatic Toxicology, Vol. 6, No. 3, p 165-177, May, 1985. 4 Fig, 2 Tab, 39 Ref.

Descriptors: *Toxicity, *Bioassay, *Cytotoxicity, *Genotoxicity, *Cell cultures, *Marine sediments, *Puget Sound, *Washington, Water pollution effects, Fish physiology, Sediments, Halogenated hydrocarbons, Benzo(a)pyrene, Nitrosamides, Polychlorinated biphenyls, Heavy metals.

Fish cell cultures were used to determine whether in vitro aquatic animal cell culture systems were capable of detecting pollution in the marine environment. Cells derived from rainbow trout gonad (RTG-2) and bluegill fry tissues (BF-2) were used as model cell systems to measure cytotoxicity and genotoxicity following exposure to Puget Sound sediment extracts, benzo(a)pyrene and MNNG (a nitrosamide). Sediment was collected from several sites within Puget Sound known to be contaminated with compounds such as polycyclic aromatic hydrocarbons, polychlorinated biphenyls, chlorinated hydrocarbons and heavy metals. Each of the sediment samples was extracted with organic solvents and added to cultures of the two model cell systems in DMSO. Following exposure the cultures were evaluated for cell death, mitotic inhibi-

tion, stimulatory effects, and chromosomal damage. These cell cultures responded to the sediment extracts much as they did to known mutagenic/carcinogenic chemicals which were used as model compounds. Those sediments known to be contaminated, based on chemical analysis and historical use patterns were also found to be qualitatively and quantitatively more toxic than were sediments from areas which were relatively unaffected by human activity. The results show that in vitro cell systems are capable of detecting pollution in the marine environment and have the potential of being powerful tools in aquatic toxicology in conjunction with whole animals or as a method of screening materials prior to in vivo testing. (Author's abstract)
W86-01158

UPTAKE, BIOTRANSFORMATION, AND ELIMINATION OF ROTENONE BY BLUEGILLS (LEPOMIS MACROCHIRUS),
National Fishery Research Lab., La Crosse, WI.
W. H. Gingerich, and J. J. Rach.
Aquatic Toxicology, Vol. 6, No. 3, p 179-196, May, 1985. 4 Fig, 3 Tab, 28 Ref.

Descriptors: *Fate of pollutants, *Bluegill, *Fish physiology, *Bioconcentration, *Rotenone, *Insecticides, *Biotransformation, Pesticides, Water pollution effects, Animal tissues, Fish tissues, Animal physiology, Metabolism.

Yearling bluegills (Lepomis macrochirus) were exposed to sublethal concentrations of C-14 rotenone (5.2 micro-g/l) for 30 days in a continuous flow exposure system and then transferred to clean, flowing water for an additional 21-day depuration period. Rates of uptake and elimination and profile of the rotenoid metabolites in head, viscera, and carcass components were evaluated by C-14 counting and by high performance liquid chromatography. Total C-14 rotenone derived activity was relatively uniform in all body components within 3 days after initial exposure and remained constant during the ensuing 27 days of exposure. Initial uptake rate coefficients were highest in viscera (K sub u = 80/h) and were nearly identical for head (K sub u = 14/h) and carcass (K sub u = 10/h). Analyses of tissue extracts by high performance liquid chromatography confirmed the presence of at least six biotransformation products of rotenone. More than 60% of the activity extracted from viscera was present as a single peak which represented a compound that was extremely soluble in water. Rotenone composed only 0.3% of the extractable activity in viscera taken from fish exposed to rotenone for 30 days; however, rotenone accounted for 15.4% of extractable activity in the head and 20.1% in the carcass components. Rotenolone and 6',7'-dihydro-6,7'-dihydroxyrotenolone were tentatively identified as oxidation products in all tissue extracts. Elimination of C-14 activity from all body components was biphasic; both phases followed first-order kinetics. The rate of elimination was nearly equal for all body components during the initial phase but was most rapid from viscera during the second phase of elimination. Bioconcentration factors for the head, viscera, and carcass were 165, 3,550, and 125, respectively, when calculated on the basis of total C-14 activity but only 25.4, 11, and 26 when calculated as the concentration of parent material. (Author's abstract)
W86-01159

QUANTITATIVE STRUCTURE ACTIVITY RELATIONSHIPS AND MIXTURE TOXICITY STUDIES OF ALCOHOLS AND CHLOROHYDROCARBONS: EFFECTS ON GROWTH OF DAPHNIA MAGNA,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Veterinary Pharmacology, Pharmacy and Toxicology.
J. Hermens, E. Broekhuyzen, H. Canton, and R. Wegman.
Aquatic Toxicology, Vol. 6, No. 3, p 209-217, May, 1985. 2 Fig, 6 Tab, 14 Ref.

Descriptors: *Toxicity, *Synergistic effects, *Daphnia, *Growth, *Alchohols, *Chlorinated hydrocarbons, *Structure activity relationships, *Mixtures, Water pollution effects, Chlorobenzenes, Mixture toxicity index, No observable effects concentration, Crustaceans.

The joint effects of mixtures of several similarly acting compounds were assayed in acute and subacute toxicity experiments with several aquatic species. The classification of the several groups was based on quantitative structure-activity relationships (QSARs). A close realtionship indicates a similarity of mode of action for the chemicals within the group studied. Effects on growth of Daphnia magna were studied for 10 non-reactive organic chemicals such as alcohols and chlorobenzenes. The 'no observed effect concentration' (NOEC) was very well correlated with the hydrophobicity (P sub oct) of the tested compounds which appeared in a QSAR study. With this QSAR the NOEC for 15 other compounds was predicted. The joint toxicity of mixtures of 10 and 25 compounds was also tested. The standard deviation in the Mixture Toxicity Index (MTI) was calculated with an estimated standard deviation in log NOEC of 0.10. The NOEC of these mixtures was predictable on the basis of concentration-additivity. It is likely that the small deviations from concentration-additivity are not systematic for mixtures of chemicals with the same modes of action, but are due to a lower reproducibility of experiments with sublethal toxicity criteria such as inhibition of reproduction or growth. Joint levels of mixtures of chemicals with similar modes of action, as indicated by QSAR studies, are concentration-additive. At levels such as NOECs with sublethal toxicity criteria joint toxicity is still present. (Collier-IVI)
W86-01160

ECOTOXICOLOGICAL ASPECTS OF PULP AND PAPER MILL EFFLUENTS DISCHARGED TO AN INLAND WATER SYSTEM: DISTRIBUTION IN WATER, AND TOXICANT RESIDUES AND PHYSIOLOGICAL EFFECTS IN CAGED FISH (SALMO GAIRDNERI),
Helsinki Univ. (Finland). Dept. of Zoology.
A. Oikari, B. Holmbom, E. Anas, M. Miilunpalo, and G. Kruzynski.
Aquatic Toxicology, Vol. 6, No. 3, p 219-239, May, 1985. 3 Fig, 9 Tab, 36 Ref.

Descriptors: *Ecological effects, *Toxicity, *Pulp and paper industry, *Industrial wastewater, *Bleaching wastes, *Phenolics, *Resin acids, *Trout, *Fish physiology, *Path of pollutants, Bioaccumulation, Blood, Animal tissues, Fish tissues, Animal physiology.

Simultaneous studies were conducted on concentrations of chlorinated phenolics (CP) and resin acids (RA) in bleached kraft pulp mill effluents (BKME), their distribution in the receiving water, their uptake and accumulation in the blood plasma of rainbow trout caged in the recipient, as well as short-term physiological effects developed in fish. RA disappeared from the lake water much faster than most of the CP. Some of the BKME-related substances (e.g. 2,4,6-trichlorophenol, 4,5,6-trichloroguaiacol, tetrachloroguaiacol and dehydroabietic acid) were also detected upstream from the mill, thus implying a low-level contamination of this water system in general. In the blood plasma of caged trout free RA were detected up to 3 km from the sewer, but free CP were analyzed as far as 11 km from the mill. During the 10-day caging period a partial inhibition of liver UDP-glucuronosyltransferase was observed even at 11 km from the BKME source. Brain acetylcholinesterase activity showed that BKME did not work like anticholinesterase agents, whereas a decrease of plasma cholinesterase activity was developed in a few days in the nearest 6 km from the sewer. Trout exposed at 6-11 km from the sewer displayed increased blood hemoglobin and decreased plasma protein concentrations. The plasma ionic picture (Na, Cl, Mg) indicated only negligible effects on fish osmoregulation. (Author's abstract)
W86-01161

FACTOR INTERACTION INFLUENCING THE DISTRIBUTION OF THE FRESHWATER 'SHRIMP' GAMMARUS,
Oslo Univ. (Norway). Biologisk Inst.
For primary bibliographic entry see Field 2H.
W86-01162

ENHANCEMENT OF MARINE PRIMARY PRODUCTION BY NITROGEN-ENRICHED ACID RAIN,
North Carolina Univ. at Morehead City. Inst. of Marine Sciences.
H. W. Paerl.
Nature, Vol. 315, No. 6022, p 747-749, 27 June 1985. 3 Fig, 7 Ref.

Descriptors: *Primary production, *Marine environment, *Nitrogen, *Acid Rain, Rain, Nutrients, Water pollution effects, Hydrogen ion concentration, Phytoplankton, Growth.

The effect of acid rain on the pH of freshwater habitats is well known. The acidity of rainwater is largely due to hydrated oxides of sulfur, nitrogen and carbon, which also constitute nutrients essential for plant growth. Most freshwater and marine environments contain sufficient quantities of inorganic carbon and sulfur to satisfy plant growth needs, but nitrogen inputs can at times fall short of growth demands. Nitrogen limitation of phytoplankton growth is widespread and chronic in some marine waters. Nitrogen-limited conditions in North Carolina near-surface waters are ameliorated following rainfall inputs; the most acidic rainfall events led to the greatest stimulation of phytoplankton growth. Continentally-derived acid rain consistently contained more inorganic nitrogen (NO3(-), NO2(-) and NH4(+)) than near neutral rainfall generated from oceanic fronts. Marine primary production can thus be influenced by the source of rainfall in marginal environments. (Author's abstract)
W86-01172

EPIDEMIOLOGICAL EVIDENCE FOR HELMINTH AND CHOLERA TRANSMISSION BY VEGETABLES IRRIGATED WITH WASTEWATER: JERUSALEM - A CASE STUDY,
Hadassah Medical School, Jerusalem (Israel). Environmental Health Lab.
For primary bibliographic entry see Field 5D.
W86-01173

OCCURRENCE OF VIRUSES IN TREATED DRINKING WATER IN THE UNITED STATES,
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5F.
W86-01193

PHOSPHORUS, NITROGEN AND CHLOROPHYLL-A CONCENTRATIONS IN A TYPICAL DUTCH POLDER LAKE, TJEUKEMEER, IN RELATION TO ITS WATER REGIME BETWEEN 1968 AND 1982,
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
For primary bibliographic entry see Field 2H.
W86-01196

ROLE OF PHYTOPLANKTON IN THE DISSOLVED OXYGEN BUDGET OF A STRATIFIED ESTUARY,
Southern Water Authority, Otterbourne (England). Resources Planning Lab.
For primary bibliographic entry see Field 2L.
W86-01197

MODELLING OF OXYGEN DEPLETION IN COASTAL WATERS,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
A. Malmgren-Hansen, P. Mortensen, and B. Moller.
Water Science and Technology, Vol. 17, No. 6/7, p 967-978, 1985. 12 Fig, 1 Tab, 5 Ref.

Descriptors: *Oxygen depletion, *Coastal waters, *Model studies, *Thisted Bredning, *Denmark, Nutrients, Wind, Mixing, Eutrophication, Wastewater pollution, Hydrography, Weather.

The relative importance of nutrient loadings and hydrographical and meteorological conditions for oxygen conditions in the Thisted Bredning, Denmark were evaluated by intensive survey and model calculations. The influence of wind speed on the vertical mixing in the unstratified shallow waters was quantified and tested in an oxygen model. The significance of oxygen consuming biological processes on the oxygen conditions were tested. By the use of a eutrophication model, the influence of local discharges of sewage on the size of the oxygen producing and oxygen consuming processes in the Thisted Bredning was calculated. Calculations showed that only a minor increase in rates of the oxygen consuming processes result in a drastic rise in the probability of oxygen depletion. (Author's abstract)
W86-01235

CONTRIBUTION OF AGRICULTURAL LOADING TO EUTROPHICATION IN FINNISH LAKES,
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 5B.
W86-01247

BIOSPHERE LEVELS OF CADMIUM, ZINC AND COPPER AROUND AN OLD SWEDISH COPPER MINE,
Linkoeping Univ. (Sweden). Dept. of Pharmacology.
C. E. Lundholm, and L. Andersson.
Ambio, Vol. 14, No. 3, p 167-172, 1985. 6 Fig, 3 Tab, 19 Ref.

Descriptors: *Water pollution sources, *Cadmium, *Zinc, *Copper, *Sweden, *Bersbo, *Mine wastes, *Metals, Heavy metals, Reeds, Rush, Crayfish, Roots, Fens, Wetlands, Animal tissues, Water pollution effects, Fate of pollutants.

The effects of heavy metals leaching from waste tips at an old copper mine in Bersbo, Sweden, on the levels of cadmium, zinc and copper in the biosphere were investigated in light of plans to drain and cultivate a nearby fenny area which is periodically flooded by runoff water from the tips. Roots from common reed (Phragmites communis) growing in nearby brooks and lakes and from the rush (Juncus effusus) growing on fenny areas that were regularly flooded by contaminated water were analyzed, and the metal concentrations in the hepato-pancreas of crayfish (Astacus fluviatilis) caught in the area were also determined. The waste tips were drained by three different brooks, all of which ultimately reached Lake Risten and further lakes downstream. The metal concentrations in the biosphere in and around the brooks and the lakes were increased up to 20-fold as far downstream as Lake Yxningen, about 15 km from Bersbo. The western part of the fenny area that was to be drained was flooded by a brook that had first passed through a marshy area abundantly overgrown with reeds, where most of the metals were retained; this western area was therefore only slightly contaminated. The eastern part of the fenny area also received a direct flow of metal-contaminated water from another brook, and metal concentrations in this part were therefore much higher. (Author's abstract)
W86-01280

RENAL PATHOLOGY IN FISH (PUNTIUS CONCHONIUS HAM.) FOLLOWING EXPOSURE TO ACUTELY LETHAL AND SUBLETHAL CONCENTRATIONS OF MONOCROTOPHOS,
D.S.B. Constituent Coll., Naini Tal (India). Dept. of Zoology.
S. Kumar, and S. C. Pant.
Bulletin of Environmental Contamination and Toxicology, Vol. 35, p 228-233, August, 1985. 6 Fig, 6 Ref.

Descriptors: *Monocrotophos, *Fish, *Toxicity, Insecticides, Organophosphate pesticides, Water pollution effects, Pesticide toxicity, Pathology, Kidney.

Pathological changes in the kidney as a result of exposing the teleost Puntilus conchonius to acutely lethal and sublethal concentrations of the organophosphate insecticide monocrotophos are reported. The release of fish into monocrotophos solutions immediately resulted in very fast and erratic swimming which calmed down to normal movements within 2-3 hr. In acutely lethal concentrations, the initial excitement was accompanied by occasional jumping. Externally, the kidneys of acutely as well as sublethally treated fish were swollen and enlarged in comparison to their normal size. In acute concentration, some significant changes were noted in the kidneys of P. conchonius. Within 24 hr, the glomeruli of the majority of Malpighian corpuscles had undergone a marked contraction so that a prominent gap was seen between them and the capsular walls. In sublethal bioassay, as early as 2 days post exposure, vasodilation and tubular atrophy by way of hydropic vacuolation in the cells had become quite evident. Monocrotophos appears to be a stronger nephral poison than formothion for fish as, besides hydropic degeneration of tubules, it also caused glomerular contraction, vasodilation and dissolution of lymphodial tissue to form blood-sinuses. (Baker-IVI)
W86-01281

EFFECT OF ANILINE ON CHLORELLA VULGARIS,
North Carolina State Univ. at Raleigh. Dept. of Zoology.
H. M. Ammann, and B. Terry.
Bulletin of Environmental Contamination and Toxicology, Vol. 35, p. 234-239, August, 1985. 3 Fig, 8 Ref.

Descriptors: *Aniline, *Algae growth, *Chlorella, *Water pollution effects, Organic compounds, Industrial wastes, Dye industry wastes, Respiration, Photosynthesis.

Release of hazardous waste into the aquatic ecosystem produces a variety of complex responses beyond lethality to specific organisms. Hidden injury, such as inhibition of photosynthesis, or changes in oxygen consumption, must significantly affect the role that a primary producer plans in the food pyramid. Threshold concentrations of aniline (a component of dye industry effluents) which affect growth of algae are established. Results show that aniline not only significantly affects growth of Chlorella vulgaris, but also affects respiration and photosynthesis. Comparison of the growth curve with oxygen consumption at 255.5 ppm may explain decreased oxygen consumption as a factor in decreased population density. However, the decline in rate of photosynthesis occurred at an aniline concentration (173.44 ppm) below that considered critical for growth. Since Federal standard emphasize effects on growth as a primary determinant in establishing exposure limits for aquatic organisms to chemical compounds it seems obvious that this is not the only parameter to be measured if aquatic ecosystems are to be preserved. Primary producers would be eliminated over time through sub-lethal exposures with subsequent severe damage, if not elimination of entire food pyramids. (Baker-IVI)
W86-01282

GENOTOXIC ACTIVITY OF PARTICULATE MATERIAL IN PETROLEUM REFINERY EFFLUENTS,
McMaster Univ., Hamilton (Ontario).
C. D. Metcalfe, R. A. Sonstegad, and M. A. Quilliam.
Bulletin of Environmental Contamination and Toxicology, Vol. 35, p 240-248, August, 1985. 6 Fig, 2 Tab, 13 Ref.

Descriptors: *Oil industry, *Industrial wastes, *Particulate matter, *Genotoxicity, Ames test, Mutagenicity, Clastogenicity, Water pollution effects, Effluents.

The genotoxic hazard associated with the discharge of suspended particulates in oil refinery effluents was evaluated. Particulate extracts were tested by in vitro assays for mutagenic and clastogenic activity, both with and without mammalian microsomal activation. In 2 of 3 conventional refineries tested significant mutagenic activity was found in the particulate component of effluents, and one particulate extract gave a positive response in a sister chromatid exchange assay. The mutagenic activity of extract residues, calculated on a revertants per mg basis was lower than the activities reported for many other complex mixtures. The low genotoxic activity of residues from particulates would seem to indicate that the discharge of mutagens in refinery effluents is low. However, the amount of this residue released in particulates from a refinery may total tons per day. Based upon a mutagenic response of 52 revertants per microgram of benzo(a)pyrene in the Ames test, each mg of residue extracted from Refinery 3 particulates contains mutagenic activity equivalent of 1.9 micro-g of benzo(a)pyrene. Therefore, discharges from this refinery are equivalent in mutagenic yield to approximately 1.0 kg of benzo(a)pyrene per day. It is possible that long term accumulation of genotoxic compounds from refineries may represent a hazard to sources of drinking water. The magnitude of this hazard would depend on parameters affecting the fate of the suspended particulates and associated genotoxic compounds. (Baker-IVI)
W86-01283

EFFECT OF POLYNUCLEAR HYDROCARBONS ON ALGAL NITROGEN FIXATION (ACETYLENE REDUCTION),
Oklahoma State Univ., Stillwater. Dept. of Zoology.
M. V. Bastian, and D. W. Toetz.
Bulletin of Environmental Contamination and Toxicology, Vol. 35, p 258-265, August, 1985. 3 Fig, 28 Ref.

Descriptors: *Polynuclear hydrocarbons, *Algal growth, *Nitrogen fixation, *Acetylene reduction, Nitrogen, Bioassay, Hydrocarbons, Naphthalene, Phenanthrene.

The reduction of acetylene to ethylene was determined as a measure of the capacity of an organism to fix atmospheric nitrogen and reduce it to an assimilable form. The primary advantage of this assay is its speed since chemical exposure and quantitative chromatographic analysis can be complete in a few hours. Cells exposed to naphthalene had markedly lower acetylene reduction activity (ARA) at all levels of exposure than the control. Cells exposed to phenanthrene also reduced acetylene at a lower rate. Exposure of cells to other 3-ringed PAHs resulted in a lower rate of ARA only at higher exposure levels or in no effects. Exposure of cells to four-ringed compounds resulted in either a slight reduction at the highest exposure level or in no inhibition. Attempts to correlate statistically either the absolute or relative decrease in ARA to toxicant concentration or to the partition coefficients of toxicants were unsuccessful. It had been expected that standardized physiological status of the exposed cells would be achieved during exponential growth. However, this was not the case. Different responses may be due to changes which affect the enzyme systems responsible for ARA. The results suggest that workers should run several experiments when testing a compound for toxic effects on ARA, particularly if the compound has a low solubility in water. (Baker-IVI)
W86-01285

5D. Waste Treatment Processes

MICROFAUNA DISTRIBUTION IN SHALLOW MACROPHYTE-COVERED BASINS,
Parma Univ. (Italy). Ist. di Ecologia.
P. Madoni, and P. Viaroli.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2353-2355, 1985. 3 Fig, 3 Ref.

Descriptors: *Protozoans, *Duckweed, *Wastewater treatment, *Macrophytes, Wastewater lagoons, Microorganisms, Species composition, Species distribution.

Succession of ciliated Protozoa was observed in May and June and again in August through October in two ponds in which Lemna gibba (duckweed) was being cultivated. The two basins were

in series, connected by gravity, and had a total area of 100 sq m; each basin had an average depth of 0.63 m. The system was fed with sewage from facultative lagoons, which received the effluents from a pig farming operation. Metopus spiralis was observed once on the bottom of the second basin; otherwise all ciliates were found in the 0.0-0.05 m surface layer. The species composition and distribution of ciliated Protozoa were similar in the two basins, despite differences in physico-chemical conditions, and despite the fact that L. gemma was not cultivated in the second basin in the second phase of the experiment. In basin 1, development of a considerable quantity of microphytes resulted from duckweed feeding, with a net increase in chlorophyll a. Microfauna development was not favored by these conditions. The layer of macrophytes, especially duckweed, seemed to be a favorable microhabitat for ciliated microfauna, particularly the epibiotic species. The first colonization phase was characterized by swimming or planktonic ciliates such as Didinium nasutum, Mesodinium pulex, Paramecium caudatum, and Tracheophyllum pusillum. Epibiotic forms ultimately succeeded these species. Vorticella convallaria, V. microstoma, Pyxidium invaginatum, and Chilodonella uncinata seemed to be particularly associated with duckweed. (Rochester-IVI)
W86-00951

SHORT-TIME DETERMINATION OF THE QUALITY OF THE EFFLUENT FROM ACTIVATED SLUDGE PLANTS ON THE BASIS OF THE RESPIRATION ACTIVITY (KURZZEITERMITTLUNG DER ABLAUFQUALITAT VON BELEBTSCHLAMMANLAGEN ANHAND DER ATMUNGSAKTIVITAT),
VEB Wissenschaftlich-Technisches Zentrum der Zellstoff- und Papierindustrie, Heidenau (German D.R.).
R. Sporl, and J. Milz.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 85-90, 1985. 3 Fig, 2 Ref.

Descriptors: *Activated sludge process, *Effluent, *Respiration, Process control, Pulp wastes, Wastewater treatment, Biochemical oxygen demand, Quality control.

For checking the quality of the effluent from an activated sludge plant for wastewaters from the sulfite pulp production the respiration of an activated sludge sample in air-saturated water is determined initially without the addition of substrate (ground respiration) and after that with an addition of substrate (methanol, substrate respiration) by means of the Clark-electrode. The measuring device is designed by means of zero displacement in such a way that the difference of the oxygen concentrations is indicated by a time relay as the difference quotient. Between the ground respiration and the effluent concentration of BOD5 exists a significant positive regression, which can be used for controlling the plant. The determination of the substrate respiration serves only for checking with respect to perhaps given inhibition of the conversion of matter by the activated sludge. The determination of the activity of the activated sludge sample takes only 20 min; inclusive of the required determination of the dry matter of sludge, the technique provides a well reproducible measured value for the biochemical conversion in the activated sludge plant within 1-1.5 h. (Author's abstract)
W86-01013

TREATMENT OF INDUSTRIAL WASTEWATERS CARRYING OILY EMULSIONS, SURFACTANS AND SULPHATES,
Wroclaw Technical Univ. (Poland). Inst. of Environment Protection Engineering.
E. Gomolka, and B. Gomolka.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 91-97, 1985. 3 Fig, 4 Tab, 4 Ref.

Descriptors: *Detergents, *Oil pollution, *Sulfates, *Industrial wastewater, *Wastewater treatment, Chemical precipitation, Barium chloride, Coagulation, Alum, Sorption, Polyurethane foam.

The major pollutants present in the wastewater from an industrial plant producing surfactants and other chemicals used in the textile, leather and cosmetic industries are detergents, oily emulsions, sulfates and organics. Laboratory investigations show that the removal efficiencies for detergents and oily emulsions are high when the wastewater is treated in a two-stage process consisting of chemical precipitation with barium chloride and alum coagulation. The coagulation may also involve the addition of sulfates in order to provide for a complete removal of barium ions. The effluent is clarified and colorless, and the concentrations of pollutants present comply with the required standards. An advantage to the use of barium chloride is that the detergents and oily emulsions present in the wastewater are precipitated. Sulfates, which occur at concentrations above the admissible levels, are also subject to precipitation. Oil spills can be successfully removed with polyurethane foams characterized by a high sorbing capacity. (Moore-IVI)
W86-01014

DESIGN AND OPERATION OF BARDENPHO PLANTS IN AN AFRICAN COUNTRY,
Meiring and Partners, Pretoria (South Africa).
J. L. Barnard.
Water Pollution Control, Vol. 83, No. 4, p 443-449, 1984. 4 Fig, 3 Tab.

Descriptors: *Wastewater treatment, *South Africa, *Bardenpho process, Nutrient removal, Design criteria, Biological wastewater treatment, Operation, Phosphates, Aeration.

The suitability of the Bardenpho process for nutrient removal prior to discharge to stream was investigated in South Africa for sewage treatment. Unfortunately, the plants were operated with a minimum of analytical data. The COD:Total N ratio of the crude sewage for all plants was favorable, being mostly about 12:1. This may decrease to below 10:1 after primary sedimentation. The type of design used for the rural plant No. 2 is in many ways similar to channel type plants but has several other advantages: the aeration basin could be much deeper and the plant more compact, vertical spindle surface aerators could be used in the Carousel system allowing for larger individual units to be used; aeration and denitrification could be controlled simply by switching aerators in and out using timers and by manual weir control, the aerators could be concentrated towards the outlet of the basin thus ensuring that a good aerated regime exists before the final clarifier and a high degree of nitrification is achieved with good denitrification, a quick turn around of the bacterial mass to the anoxic zone, and overall simplicity of the system. While it is sometimes felt that it takes less skill to operate a biological filter plant with chemical additions for phosphate removal, this could be true only if no attention is paid to cost and to secondary pollution that results, as all that is required is to overdose the plant in order to precipitate phosphates. (Baker-IVI)
W86-01015

TREATMENT OF WASTE WATER FROM THE LEATHER INDUSTRY,
Leather Industries Research Inst., Grahamstown (South Africa).
D. R. Cooper, S. G. Shuttleworth, and N. P. Slabbert.
Water Pollution Control, Vol. 83, No. 4, p 450-454, 1984. 7 Tab.

Descriptors: *Tannery wastes, *Wastewater treatment, *Industrial wastes, Aeration, Flotation, Activated sludge process, *Biological wastewater treatment, Chromium, Sulfides, Suspended solids, Effluents.

Possible suggestions are offered for the treatment of effluent from a chrome leather tannery. For mixed tannery effluent, all process liquors should be balanced and aerate in balancing tanks for 24 hr to remove sulfide. This effluent would not be suitable for municipal discharge because of high concentrations of SS, settleable solids and chromium content. Physico-chemical treatment involves ferric chloride and polyelectrolyte dosing plus air flotation. This effluent should be suitable for municipal discharge since most of the chromium would have been removed together with the suspended solids. The lower oxygen demand of the treated effluent will ensure acceptability of the effluent as far as organic content is concerned. Only the inorganic levels, as reflected by the total dissolved solids (mainly inorganics), sulfate and chloride contents, could possibly exceed the discharge limits of some municipalities. Further organics removal could be obtained by biological treatment, by activated sludge or high rate filter. A stepwise treatment, i.e. physico-chemical followed by biological treatment, is better and easier for highly-polluted tannery effluents than a single activated sludge process. Fresh water discharge would still not be possible since with even the best available effluent treatment of tannery effluents, the general/special standards for rivers will not be met. (Baker-IVI)
W86-01016

POTENTIAL OF ANAEROBIC DIGESTION FOR TREATING LIQUID WASTES,
Birmingham Univ. (England). Dept. of Civil Engineering.
C. G. Forster.
Water Pollution Control, Vol. 83, No. 4, p 484-490, 1984. 7 Fig, 2 Tab, 26 Ref.

Descriptors: *Wastewater treatment, *Anaerobic digestions, Industrial wastes, Evaluation, Anaerobic expanded bed process, Biological wastewater treatment.

The potential for using anaerobic digestion as a method for treating liquid wastes was examined. Laboratory scale digesters have been shown to be useful in evaluating the compatibility of a process and a particular effluent. Design options that are available are considered along with design criteria which must be met. The results indicate that the anaerobic expanded bed (AEB) process exhibits a large degree of dispersion irrespective of the hydraulic retention period being used. In other words, the system is well-mixed. No short circuiting was occurring. The data also indicates that the AEB system, and probably other types of anaerobic digesters, is not a suitable method for the treatment of effluents with a strength as low as that of normal domestic sewage unless it is considered merely as a roughing process. This study also showed an additional and interesting point. On a number of occasions air entered the system, either when pump tubing failed or when the bed had to be opened for minor repairs. This did not appear to have any significant effect on the performance indicating that, contrary to most of the literature, the anaerobic microbial flora is extremely robust. (Baker-IVI)
W86-01018

APPLICATION OF ANAEROBIC PACKED-BED REACTORS TO INDUSTRIAL WASTEWATER TREATMENT,
Newcastle upon Tyne Univ. (England). Public Health Engineering Div.
G. K. Anderson, K. J. McKeown, and T. Donnelly.
Water Pollution Control, Vol. 83, No. 4, p 491-498, 1984. 1 Fig, 3 Tab, 13 Ref.

Descriptors: *Anaerobic digestion, *Industrial wastes, *Packed bed reactors, Filters, Filtration, Biodegradation, Biological wastewater treatment.

The treatment of organic waste waters by anaerobic packed-bed reactors offers considerable advantages over other types of anaerobic treatment systems. They have been proven over a wide range of industrial waste waters with considerable variation in concentration of organic matter. The reactors are able to maintain a high biomass concentration with attachment of both acidogenic and methanogenic bacteria. This enables a high BOD load to be applied while concurrently offering stability under varying load conditions and inhibitive conditions. Careful research and design can optimize treatment efficiency and methane production and, together with control of sulfide production in the appropriate situations, it is anticipated that a wide range of wastewaters will be treated by this method. (Baker-IVI)

W86-01019

ANAEROBIC TREATMENT OF WASTE WATERS IN THE BEET SUGAR INDUSTRY,
British Sugar Corp. Research Labs., Norwich (England).
M. Shore, N. W. Broughton, and N. Bumstead.
Water Pollution Control, Vol. 83, No. 4, p 499-506, 1984. 4 Fig, 3 Tab, 22 Ref.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Food processing industry, Beets, Industrial wastes, Water reuse, Methane, Fuel.

Beet sugar production requires substantial volumes of water, but in modern beet sugar factories most of it is recycled. The theoretical volume of effluent at the British Sugar factory at Bury St. Edmunds exceeds 100 tcmd, but treatment and re-use have reduced this to only 4.8 tcmd. Most of this originates from incoming water in the beets which is not eliminated either in the end-products or in evaporation to atmosphere. Anaerobic processes developed in the last decade specifically for the beet sugar industry have the advantages of a much lower input energy cost and production of the valuable fuel methane to offset their high capital cost. The four main methods of anaerobic treatment in general use in the industry are the Anamet, IRIS, Anodek, CSM processes. The Anamet plant commissioned at Bury St. Edmunds factory during the 1982-1983 processing season is described. During the last three of the five weeks operations for which results are available, the plant routinely removed about 90% of the influent COD and had a daily methane production which, maintained for a full processing season, would be worth more than 22,000 pounds as a fuel oil replacement. When fully operational, the plant is expected to yield methane worth nearly three times this amount from the removal of more than 16 t COD/day. (Baker-IVI)
W86-01020

ANAEROBIC DIGESTION OF AGRICULTURAL WASTES,
Rowett Research Inst., Bucksburn (Scotland). Dept. of Microbial Biochemistry.
P. N. Hobson.
Water Pollution Control, Vol. 83, No. 4, p 507-513, 1984. 1 Tab, 11 Ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Farm wastes, Nitrogen, Bacteria, Methane, Energy, Animal wastes, Crop wastes, Silage liquid, Waste disposal.

Gas production from the farm digester treating animal slurries could be boosted at times by adding to the slurry silage liquid (a potential cause of heavy pollution of water courses), and crop wastes. Waste vegetable matter would have to be macerated before it could be pumped with slurry. Maximum use of all products of digestion is desirable and uses of digested slurry other than for fertilizer are envisaged and are being tested. A protein, or protein plus ammonia, nitrogen supplement to farm animal feeds is a possibility. A problem arises due to the large liquid volume of the slurry. A suitable, low-cost, low-energy method of concentrating and drying the slurry solids containing the bacterial protein has not yet been devised. Making silage could be a way of mopping up the liquid, or mixing with grain to form a liquid feed is also possible. Hydroponics, fish farming, growing of worms or algae, are all possible uses for digested slurries; experiments on these and other uses are being carried out. (Baker-IVI)
W86-01021

EXPERIENCE WITH THE ANODEK PROCESS,
Dunlop Bioprocess, Birmingham (England).
G. G. Morris, and S. Burgess.
Water Pollution Control, Vol. 83, No. 4, p 514-520, 1984. 1 Fig, 10 Tab, 5 Ref.

Descriptors: *Anodek process, *Methanogenesis, *Anaerobic digestion, Methane bacteria, Acetogenic bacteria, Biological wastewater treatment, Biogas.

Anaerobic digestion is usually achieved in one step with the entire process (acidogenesis and methanogenesis) taking place in one reactor. The two stage Anodek process is based on the fact that the methanogens can only utilize a limited number of intermediates. These are methanol, hydrogen, formate and acetate. The methanogens have to directly remove the hydrogen produced by the obligatory hydrogen producing acetogenic (OHPA) bacteria in order to favor the thermodynamic conditions for growth of their syntrophes, the OHPA bacteria. Therefore, technically the OHPA bacteria and the methanogens have to exist in physical proximity, hence in one particular reactor. In practical terms Anodek is a method for the production of methane gas and the treatment of aqueous solutions of organic compounds by means of a two stage anaerobic fermentation process. The first stage is used to solubilize/hydrolize the effluent and provide the second stage with an optimum of constant feed by various means. The second stage is a methane reactor where methane gas is produced from the conditioned feed. About 70% of the COD present in the wastewater can be rapidly converted into biogas, representing a 95% BOD reduction. (Baker-IVI)
W86-01022

LEACHATE TREATMENT WITH PARTICULAR REFERENCE TO AERATED LAGOONS,
Water Research Centre, Stevenage (England).
P. J. Maris, D. W. Harrington, and G. L. Chismon.
Water Pollution Control, Vol. 83, No. 4, p 521-538, 1984. 7 Fig, 13 Tab, 36 Ref.

Descriptors: *Leachates, *Wastewater treatment, *Aerated lagoons, Landfills, Clarification, Aeration, Waste disposal, Biological wastewater treatment, Chemical treatment, Sludge.

The development of scientific landfill management will lead to increasing constraints on leachate disposal. Leachate has particular problems notably organic strength, metals and high ammonia N content. The age and the method of emplacement of the waste play an important part in determining the nature of the leachate. Leachates from recently emplaced wastes are amenable to biological treatment while leachate from more aged waste which contains more refractory compounds may need both chemical and biological treatment. Aerobic treatment of leachate will give rise to a large quantity of sludge which will require thickening and disposal. The volume of leachate produced from a landfill will be dependent upon climatic conditions, the rate of infiltration and the degree of compaction of waste. The most effective way of reducing the volume of dump leachate is by good site engineering and management. Leachate is deficient in phosphorus, which, for effective biological treatment, must be added as a nutrient supplement. The most effective biological treatment is aerated lagooning, followed by clarification. Other options include chemical treatment, the anaerobic process, activated-sludge treatment and rotating biological contactors. Aeration of strong leachate produces large volumes of sludge. This settles readily and may be thickened up to 5.6-7.7% dissolved solids. It is imperative that the treatment process should be simple, reliable and require low maintenance and operating expertise. (Baker-IVI)
W86-01023

MOVEMENT OF SEPTIC TANK EFFLUENT THROUGH SANDY SOILS NEAR PERTH. I. MOVEMENT OF NITROGEN,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Animal Production.
For primary bibliographic entry see Field 5B.
W86-01034

MOVEMENT OF SEPTIC TANK EFFLUENT THROUGH SANDY SOILS NEAR PERTH. II. MOVEMENT OF PHOSPHORUS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Animal Production.
For primary bibliographic entry see Field 5B.
W86-01035

FLOW UNDER TILT SURFACE FOR HIGH-RATE SETTLING,
Osaka Univ. (Japan). Dept. of Chemical Engineering.
S. Shiba.
Journal of Environmental Engineering, Vol. 111, No. 3, p 285-303, June, 1985. 5 Fig, 3 Tab, 18 Ref, 3 Append.

Descriptors: *Settling tanks, *Flow stratification, Water treatment, Wastewater treatment, Convection, Density, Mathematical models, Simulation, Velocity, Sedimentation.

A clear layer flow rising under inclined surfaces (particle-free flow stratified on the suspension), which can be utilized for particle settling enhancement, has been theoretically analyzed in order to apply it to design and operation of high-rate settlers in water and wastewater treatments. The flow proves to be driven by settling convection due to the density difference between the clear liquid and the suspension. A mathematical model for the flow simulation has been obtained by making use of the boundary layer approximation and the clear-layer-averaged inertia terms in the momentum equations. A dimensionless number, T, which controls the model and is given by the ratio of Grashof number, Gr, to Reynolds number, R, plays an important role in the flow. The flow velocity and the layer thickness predicted by the analytical solutions agree fairly well with previous experimental results observed in a batch settler to verify the analysis. (Author's abstract)
W86-01040

CALCIUM SULFATE SOLUBILITY IN ORGANIC-LADEN WASTEWATER,
Westinghouse Electric Corp., Carlsbad, NM. Waste Isolation Pilot Plant Project.
I. Banz, and R. G. Luthy.
Journal of Environmental Engineering, Vol. 111, No. 3, p 317-335, June, 1984. 4 Fig, 5 Tab, 39 Ref.

Descriptors: *Calcium sulfate, *Solubility, *Organic matter, *Wastewater, Coal conversion wastewater, Water reuse, Makeup water, Cooling water.

Calcium sulfate solubility product and ion pair dissociation constant were measured in clean water, and these results were employed in tests with a pretreated coal conversion process wastewater to assess the tendency for organic matter in the wastewater to function as a complexing agent for calcium. It was demonstrated that wastewater organic matter interacted with calcium to form a calcium-organic complex. The extent of this interaction in wastewater was as significant as that for formation of the CaSO4(0) ion pair in assessing solubility of CaSO3. It was shown that the organic matter complexed with calcium to an extent comparable to humic acid, and that the complexing strength was similar to that predicted for citrate when compared on an equivalent COD or TOC basis. The results of this study are important for evaluating CaSO4 scale-forming reactions if wastewater is to be reused as makeup water to an evaporative cooling tower. (Author's abstract)
W86-01042

HEAD-DISCHARGE RELATION FOR VORTEX SHAFT,
Ecole Polytechnique Federale de Lausanne (Switzerland). Chaire de Constructions Hydraulics.
For primary bibliographic entry see Field 8B.
W86-01053

REMOVAL OF PESTICIDES IN WATER BY MICROBIAL CELLS ADSORBED TO MAGNETITE,
Queensland Univ., Brisbane (Australia). Dept. of Microbiology.
For primary bibliographic entry see Field 5F.
W86-01057

IDENTIFICATION AND TREATABILITY OF ORGANICS IN OIL SHALE RETORT WATER,
Queensland Univ., Brisbane (Australia). Dept. of

Chemical Engineering.
K. R. Dobson, M. Stephenson, P. F. Greenfield, and P. R. F. Bell.
Water Research, Vol. 19, No. 7, p 849-856, 1985. 5 Fig, 8 Tab, 13 Ref.

Descriptors: *Oil shale retort water, *Organic compounds, *Wastewater treatment, Biodegradation, Adsorption, Activated carbon, Oxidation, Ozonation.

Analysis by GC-MS of the process water derived from Fischer Assay retorting of oil shale from Rundle, Australia has provided positive identification of the major organic constituents present. This is the first detailed analysis of retort water from Australian oil shales and showed that the compounds ranged from being highly biodegradable to highly inhibitory and resistant to biological oxidation. The major classes of compounds found in a composited sample included normal carboxylic acids, alkyl pyridines, quinolines and cyclic saturated and unsaturated ketones. Separation of the retort water into its acid, base and neutral fractions was brought about by solvent extraction using methylene chloride. A series of treatability studies on the retort water confirmed the hypothesis that only a portion of the organic carbon was amenable to biological treatment. In addition, high ammonia levels further inhibited biological action. Adsorption of the retort water with activated carbon proved most successful in removing the non-biodegradable fraction of the organic species. Chemical oxidation by ozone does not appear attractive because it lacks the specificity of adsorption. (Author's abstract)
W86-01060

BORON POLLUTION IN THE SIMAV RIVER, TURKEY AND VARIOUS METHODS OF BORON REMOVAL,
Marmara Scientific and Industrial Research Inst., Gebze (Turkey). Dept. of Chemical Engineering.
O. Okay, H. Guclu, E. Soner, and T. Balkas.
Water Research, Vol. 19, No. 7, p 857-862, 1985. 9 Fig, 1 Tab, 19 Ref.

Descriptors: *Boron, *Wastewater treatment, *Mine drainage, *Simav River, *Turkey, Adsorption, Ion exchange, Magnesium oxide, Resins, Cellulose, Water pollution control.

The boron mines in the Bigadic district of Turkey discharge significant amounts of drainage water into the Simav River, which supplies irrigation water for agricultural land. Boron removal from the drainage waters using alpha-cellulose, magnesium oxide and boron-specific resin Amberlite IRA-743 was investigated. Both the adsorption method using magnesium oxide and the ion-exchange operations are effective in removing boron from the drainage waters. Cellulose as an adsorbent has a minimum efficiency. MgO can be used for three cleaning cycles with 85% removal efficiency but must be discharged and regenerated after the third cycle. Consumption of 18,100 tons of MgO per year in the removal system makes this process uneconomical. Boron-specific resin Amberlite IRA-743 in free-amine form is also uneconomical due to expensive regeneration steps. The capacity of this resin in salt-form was found to be 1.5 mg boron/ml resin at 10% boron leakage and at a flow rate of 16 l/h/l. The possibility of reuse of 90% of the regenerant and production of 4400 tons of boric acid in the removal system with salt-form boron-specific resin would compensate for the annual cost of chemicals and also provide some profit. (Moore-IVI)
W86-01061

COPPER(II) REMOVAL FROM AQUEOUS SOLUTIONS BY FLY ASH,
Banaras Hindu Univ., Varanasi (India). Inst. of Tech.
K. K. Panday, G. Prasad, and V. N. Singh.
Water Research, Vol. 19, No. 7, p 869-873, 1985. 7 Fig, 2 Tab, 24 Ref.

Descriptors: *Adsorbents, *Copper, *Fly ash, Wastewater treatment, Adsorption, Heavy metals, Hydrogen ion concentration, Temperature effects.

Adsorption at solid-solution interfaces is an important means of controlling the extent of pollution due to metallic species in industrial effluents, but the use of activated carbon is not suitable for developing countries due to its high cost. The use of fly ash from thermal powerplants as an adsorbent for the removal of Cu(II) for aqueous solutions was studied and 100% removal was noted when the solution concentration was initially at 1.0 x 10 to the -4 M. The removal of Cu(II) by adsorption on fly ash is concentration, pH and temperature dependent. The kinetics of adsorption indicates the process to be diffusion controlled. The Langmuir constants were calculated at different temperatures, and the adsorption was found to be endothermic (delta H = 15.652 kcal/mol). The maximum removal is observed at pH 8.0. The hydrolyzed species of Cu(II) are involved in complexation with surface active sites of fly ash. (Moore-IVI)
W86-01062

PERSISTENT CHEMICALS IN PULP MILL EFFLUENTS OCCURRENCE AND BEHAVIOUR IN AN ACTIVATED SLUDGE TREATMENT PLANT,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
C. Leuenberger, W. Giger, R. Coney, J. W. Graydon, and E. Molnar-Kubica.
Water Research, Vol. 19, No. 7, p 885-894, 1985. 5 Fig, 5 Tab, 37 Ref, 1 Append.

Descriptors: *Pulp wastes, *Activated sludge process, *Chlorinated hydrocarbons, Wastewater treatment, Chlorinated phenols, Chloroform, Chlorinated terpenoids, Chlorinated resin acids, Adsorption, Water pollution, Switzerland.

In wastewater effluents of a Swiss pulp mill more than 50 organic chemicals were identified including chlorinated phenols, chloroform, chlorinated terpenoids and chlorinated resin acids. Quantitative determinations were carried out to investigate the behavior of the most abundant constituents during wastewater treatment in an activated sludge process. In particular, the chlorinated compounds were only partly eliminated. The lipophilic chlorinated phenols were physically absorbed to some extent into the activated sludge biomass. The importance of this nonbiological elimination mechanism was evaluated by applying distribution coefficients between activated sludge particles and water which were determined for a series of chlorinated phenols. Chloroform and other purgeable compounds were removed mainly by transfer into the ambient air. The impact of the persistent wastewater constituents on the water qualtity in the receiving River Aare was assessed. It was estimated that the concentrations of chlorinated phenols in the river caused by the discharge of the treated pulp mill wastewater are about 10 time lower than the levels of pentachlorophenol which typically occur in Swiss rivers receiving effluents from municipal wastewater treatment plants. (Author's abstract)
W86-01064

LEACHATE TREATMENT WITH NITRIFICATION OF AMMONIA,
Cleanaway Ltd., Rayleigh (England).
K. Knox.
Water Research, Vol. 19, No. 7, p 895-904, 1985. 8 Fig, 5 Tab, 11 Ref.

Descriptors: *Landfill leachates, *Wastewater treatment, *Nitrification, *Ammonia, Leachates, Activated sludge process, Trickling filters, Biological wastewater treatment, Organic carbon, Temperature effects, Seasonal variation.

Small outdoor activated sludge and trickling filter plants were operated for 2 years to investigate nitrification in a leachate from a long-established co-disposal landfill. There has been little long-term change in leachate quality at the site, but seasonal fluctuations were observed. Leachate ammonia nitrogen concentrations ranged from 150 to 550 mg/l while total organic carbon (TOC) concentrations ranged from 200 to 500 mg/l. This suggested that NH3-N concentrations were influenced by factors additional to those which produced the variations in TOC concentrations. Very little of the TOC was degradable and BOD:NH3-N ratios were typically 1:3. In the activated sludge plant, clarification was poor. This was at least partly attributed to the low BOD:NH3 ratio. Fewer problems of this sort occurred in the biological filter. Nitrification was successfully established in both plants, and curves were established for the response of the kinetics to different temperatures. The highest ammonia removal rate achieved in the activated sludge plant was 131 g N/kg VSS/day achieved at an average temperature of 13 C. The maximum removal rate in the trickling filter was 309 mg N/sq m/day, at 16 C. This is similar to nitrification rates reported for sewage at similar temperatures. The sensitivity of the process to temperature and the disproportionate production of leachate in winter months indicate that full-scale plant design would be optimized if leachate were stored on-site during winter months for treatment during warmer weather. (Moore-IVI)
W86-01065

EPIDEMIOLOGICAL EVIDENCE FOR HELMINTH AND CHOLERA TRANSMISSION BY VEGETABLES IRRIGATED WITH WASTEWATER: JERUSALEM - A CASE STUDY,
Hadassah Medical School, Jerusalem (Israel). Environmental Health Lab.
H. I. Shuval, P. Yekutiel, and B. Fattal.
Water Science and Technology, Vol. 17, No. 4/5, p 433-442, 1985. 3 Fig, 11 Ref.

Descriptors: *Wastewater irrigation, *Epidemiology, *Cholera, *Parasites, *Jerusalem, *Israel, Public health, Diseases, Wastewater disposal, Wastewater treatment, Water reuse, Pathogens, Agriculture.

This paper reviews and reanalyzes epidemiological data on the transmission of the helminthic diseases ascariasis and trichuriasis as well as cholera by vegetables and salad crops irrigated with untreated wastewater in Jerusalem between 1935 and 1982, based on a series of published papers and unpublished reports not generally available to professionals in the field of water pollution control. The findings provide strong evidence that both Ascaris and Trichuria infections were actively and massively transmitted to the general public who consumed vegetables irrigated with raw wastewater. The levels of infection dropped dramatically when the supply of contaminated vegetables was cut off but increased again rapidly on reintroduction of the wastewater-irrigated crops. The infection level subsided again when the practice was finally stopped in 1970. The epidemiological evidence from the 1970 cholera outbreak in Jerusalem indicates that wastewater-irrigated vegetables were the primary route of secondary infection once a few subclinical or clinical cases of cholera entered the city from areas outside the country where a cholera epidemic was underway. The evidence also indicates that farmers in an area where cholera is not endemic are particularly at risk when practicing irrigation with raw wastewater from a city undergoing a cholera outbreak. The need to treat wastewater to remove these pathogens prior to the irrigation of such vegetable crops is stressed. (Author's abstract)
W86-01173

WASTEWATER TREATMENT BY ARTIFICIAL WETLANDS,
Ecological Research Associates, Davis, CA.
R. M. Gersberg, B. V. Elkins, and C. R. Goldman.
Water Science and Technology, Vol. 117, No. 4/5, p 443-450, 1985. 5 Fig, 1 Tab, 10 Ref. EPA grant CR-807299-03-0, California Department of Water Resources grant B-53459 AM IV.

Descriptors: *Wastewater treatment, *Artificial wetlands, *Wetland treatment, Secondary wastewater treatment, Advanced wastewater treatment, Nitrogen removal, Biochemical oxygen demand, Suspended solids, Costs.

This report describes studies of artificial wetlands at Santee, California which demonstrate the capacity of these systems for integrated secondary treat-

ment (BOD and suspended solids removal) and advanced treatment (nitrogen removal) of municipal wastewater effluents. When receiving a blend of primary and secondary wastewaters at a blend ratio of 1:2 (6 cm per day 1 degrees: 12 cm per day 2 degrees), mean removal efficiencies for a complete year of operation from July, 1982 through July, 1983 were 80% for total nitrogen (TN) and 80% for total inorganic nitrogen, with the mean inflow TN level of 21.5 mg/l reduced to a mean value of 4.3 mg/l in the wetland effluent. The BOD and suspended solids removal efficiencies were 93% and 88% respectively. The mean wetland effluent values for both BOD and suspended solids were below the 10/10 mg/l standard for advanced secondary treatment. When primary effluent was the sole source of inflow to the artificial wetlands, BOD and suspended solids levels approaching the quality of a secondary treated effluent (30/30 mg/l) could be attained at an application rate of 6-8.3 cm per day. In this case, mean BOD and suspended solids removal efficiencies for the complete year from July, 1982 through August, 1983, were 78% and 80% respectively, with the effluent levels reduced to mean values of 33 mg/l for BOD and 10 mg/l for suspended solids. At the application rate of 6 cm per day, the study shows that only 16 acres (6.5 ha) of the constructed wetlands would be required to treat 3785 cu m of primary wastewaters to secondary treatment levels. Data on capital, and operating and maintenance costs show that artificial wetlands are competitive with other treatment technologies available to small to medium sized communities. (Author's abstract)
W86-01174

USE OF PERACETIC ACID IN OPERATIONAL SEWAGE SLUDGE DISPOSAL TO PASTURE,
Interox Chemicals Ltd., Widnes (England).
J. A. L. Fraser, A. F. Godfree, and F. Jones.
Water Science and Technology, Vol. 17, No. 4/5, p 451-466, 1985. 1 Fig, 8 Tab, 50 Ref.

Descriptors: *Peracetic acid, *Disinfection, *Sludge disposal, Salmonella, Parasites, Pathogens, Pastures, Sludge treatment, Bacteria.

Intestinal pathogens and parasites are a problem associated with the disposal of sewage sludge to pasture. Those of major importance are ova of the beef tapeworm (Taenia saginata) and Salmonella bacteria. Techniques for routine monitoring of pathogens and intestinal parasite levels in sludge together with design of simple methods for their removal have intensified, because disposal of sewage sludge to pasture is coming under increasing international surveillance. The performance during field trials of a proprietary peracetic acid compound (containing 36 to 40% w/w peracetic acid), hereafter referred to as PAA (100%), is described. These trials under operational conditions showed it to be a suitable bacterial and ovicidal agent for the disinfection of raw, digested and activated sludges. Concentrations ranging from 250 to 1000 mg PAA/l have achieved up to 99% inhibition of hatching and up to 100% destruction in viability of tapeworm embryos suspended in raw and digested sludges. Similarly these concentrations resulted in 5 log, reduction in salmonellae seeded in raw sludge. A dose of 250 mg PAA/l reduced salmonellae levels from 4600 organism/100 cu cm to < 30/100 cu cm during gravity thickening of surplus activated sludge. Results from 46 tanker loads of consolidated surplus activated sludge revealed that salmonellae levels were reduced from 2400 organisms/100 cu cm to < 30/100 cu cm at doses of 500, 400 and 300 mg PAA/l. At a lower dose of 150 mg PAA/l levels were reduced to within a range of < 30 to 430 organisms/100 cu cm. At optimum disinfection concentrations for the destruction of both bacteria and parasites, PAA was rapidly utilized resulting in safe, readily biodegradable, non-toxic residuals. The technical and practical benefits, principals of disinfecting sludge and ecological safeguards are highlighted in this paper. Use is made of case histories to describe practical operating techniques. (Author's abstract)
W86-01175

SETTLING OF NUTRIENT REMOVAL ACTIVATED SLUDGES,
Johannesburg City Health Dept. Labs. (South Africa).
A. R. Pitman.
Water Science and Technology, Vol. 17, No. 4/5, p 493-504, 1985. 5 Fig, 3 Tab, 22 Ref.

Descriptors: *Activated sludge, *Sludge settling, *Aeration, Biological wastewater treatment, Nutrient removal, Dissolved oxygen, Clarifiers, Sedimentation, Sludge age.

The successful operation of the activated sludge process is greatly dependent on final clarifier performance. Final clarifier perfomance is related to activated sludge settling properties and these in turn are usually affected by operating conditions in the biological reactor. The settling properties of activated sludges from four biological nutrient removal plants were surveyed. Activated sludge settling properties showed a fair degree of variability with the two extended aeration plants exhibiting superior settling properties in comparison to the two Phoredox/Bardenpho units. One sludge had poor settling properies due to the presence of excessive filamentous growths. Settling properties could be correlated well with the degree of aeration of the activated sludge. Plants operated with an aerobic sludge age greater than 50% of the total sludge age and with aerobic zone dissolved oxygen levels above 1.0 mg/l tended to produce better settling sludges. Empirically derived constants used in the settling flux theory are correlated with more traditional measures of settling properties. An easy method of using the settling flux approach to clarifier design and operation is presented and a new parameter describing the settling properties of sludges is proposed. (Moore-IVI)
W86-01178

SLUDGE CONDITIONING: EFFECTS OF SLUDGE BIOCHEMICAL COMPOSITION,
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
P. T. Bowen, and T. M. Keinath.
Water Science and Technology, Vol. 17, No. 4/5, p 505-515, 1985. 2 Fig, 6 Tab, 25 Ref.

Descriptors: *Sludge conditioning, *Chemical composition, Sludge drying, Carbohydrates, Protein, Lipids, Polymer Index, Biopolymers, Bioflocculation.

Variations in response of three different sludges to conditioning with organic polyelectrolytes were evaluated with respect to the carbohydrate, protein and lipid content of the sludges. These biochemicals comprise the surfaces of most sludges. The difference in the concentration of these compounds is intrinsic to the sludge type. Polymer Index (PI), a measure of minimum polymer dose required to achieve maximum dewaterability, was statistically related to each of the three components. Carbohydrate content correlated most strongly with PI. As carbohydrate content increases, PI was found to decrease indicating better polymer performance. Biopolymers, which are composed mainly of carbohydrates may surround the cells forming a highly reactive surface. These exocellular materials also promote bioflocculation. Both actions result in a lower polymer requirement for destabilizing the sludge. Protein and lipid were not observed to have strong correlation with PI. Cellular surfaces and structures are composed of these components. The low correlation indicates these components are less favored than carbohydrates for polymer interaction. (Author's abstract)
W86-01179

HIGHLY EFFICIENT ANAEROBIC DIGESTION WITH THERMAL PRETREATMENT,
Kyoto Univ. (Japan). Dept. of Sanitary Engineering.
M. Hiraoka, N. Takeda, S. Sakai, and A. Yasuda.
Water Science and Technology, Vol. 17, No. 4/5, p 529-539, 1985. 7 Fig, 3 Tab, 10 Ref.

Descriptors: *Anaerobic digestion, *Thermal pretreatment, Wastewater treatment, Activated sludge, Organic matter, Fatty acids, Volatile acids, Methane.

The effectiveness of an anaerobic digestion process with thermal pretreatment at a comparatively low temperature was examined. The waste activated sludge was thermally pretreated in the process. A laboratory scale experiment and a pilot plant study were conducted. Changes in volatile acids concentration, in major constituents of sludge and in molecular size distribution were examined before and after thermal pretreatment and anaerobic digestion. Thermal pretreatment resulted in an increase of more than 30 percent in digestion gas production. The major substrates decomposd were fats in the pilot plant study. Glyceride fatty acids are decomposed with thermal pretreatment and produce volatile acids such as acetic and propionic acids. The volatile acids are directly utilized by anaerobes to produce methane. Organic matter such as fats and carbohydrates are depolymerized with thermal pretreatment and produce soluble intermediate compounds such as higher fatty acids. The intermediates are utilized in the anaerobic digestion process. These two major effects facilitate the methane production process. (Author's abstract)
W86-01180

SLUDGE TREATMENT TECHNOLOGY AND IONIZING RADIATION,
Vyzkumny Ustav Vodohspodarsky, Prague (Czechoslovakia).
M. Sedlacek, M. Koubik, K. Vacek, and J. Rejholec.
Water Science and Technology, Vol. 17, No. 4/5, p 515-562, 1985. 5 Fig, 9 Tab, 20 Ref.

Descriptors: *Sludge treatment, *Irradiation, Disinfection, Sludge thickening, Sludge disposal, Salmonella, Economic aspects, Czechoslovakia.

The application of radiation hygienization of sludges in sewage works can be affected by secondary effects of this process. The change of the colloidal system of liquid sludges by irradiation results in an improvement of their thickening capacity, but at the same time produces an increase in the demand for polymer flocculants for the conditioning of sludges prior to their dewatering. The irradiation dose of 3 kGy decreases the concentration of Salmonella senf. by at least 6 orders, and at the same time the reinfection of the sludges by prolonged storage is suppressed. Two years of field tests showed higher potato and barley yields with irradiated sludges compared with non-irradiated sludges. The economic evaluation demonstrated under Czechoslovak conditions the suitability of the use of electron accelerators as radiation sources and the introduction of ionizing radiation behind the mechanical sludge dewatering process. (Author's abstract)
W86-01181

SLUDGE STABILISATION AND DISINFECTION BY MEANS OF AUTOTHERMAL AEROBIC DIGESTION WITH OXYGEN,
Johannesburg City Engineer's Dept. (South Africa).
B. C. Trim, and J. E. McGlashan.
Water Science and Technology, Vol. 17, No. 4/5, p 563-573, 1985. 3 Fig, 3 Tab, 10 Ref.

Descriptors: *Sludge digestion, *Autothermal aerobic digestion, *Disinfection, Sludge stabilization, Helminths, Dissolved oxygen, Aerobic digestion.

Research at pilot-scale was undertaken into autothermal aerobic digestion of sludge using oxygen to demonstrate that sufficiently high temperatures can be achieved to ensure the degree of disinfection that would satisfy the health authorities. The ova of the helminth Ascaris lumbricoides were used in the disinfection studies and the dissolved oxygen level in the sludge was used as a means of controlling oxygen consumption. The results achieved indicate that the system very rapidly attained a stable temperature which could be easily maintained and which effectively ensured disinfection of the sludge at the 2 and 4 day retention periods tested, that the treated sludge readily ferments anaerobically, that the sludge will not readily settle and is very difficult to dewater. (Author's abstract)
W86-01182

DECONTAMINATING BIOLOGICAL SLUDGE FOR AGRICULTURAL USE,
Toronto Univ. (Ontario). Dept. of Civil Engineering.
L. Wong, and J. G. Henry.
Water Science and Technology, Vol. 17, No. 4/5, p 575-586, 1985. 3 Fig, 8 Tab, 16 Ref.

Descriptors: *Bacterial leaching, *Sludge treatment, *Heavy metals, Hydrogen ion concentration, Aeration, Temperature, Cadmium, Copper, Nickel, Zinc, Lead, Sludge disposal, Land application.

A biological oxidation process called bacterial leaching was used to remove heavy metals from anaerobically digested sewage sludge. The purpose was to decontaminate the sludge so that it could be utilized on agricultural land. The leaching process was found to be affected by pH, aeration and temperature. At a pH of 4, on aeration rate of 100 cu cm of air per liter of sludge per minute and a temperature of 25 C, the following metal removal efficiencies were observed: cadmium, 80-85%; copper, 66-80%; nickel, 70-78% and zinc, 84-90%. No significant removal was observed for lead. In addition to removing heavy metals, bacterial leaching preserves the soil conditioning and fertilizing properties of the sludge. According to Ontario guidelines, the sludge used in this study was initially not acceptable for use on agricultural lands. However, after bacterial leaching, all criteria for the application of sludge to agricultural lands were easily met. (Author's abstract)
W86-01183

FRACTIONATION OF HEAVY METALS IN SEWAGE SLUDGES,
Water Research Centre, Medmenham (England). Medmenham Lab.
R. J. Oake, C. S. Booker, and R. D. Davis.
Water Science and Technology, Vol. 17, No. 4/5, p 587-598, 1985. 3 Fig, 5 Tab, 2 Ref.

Descriptors: *Sludge, *Heavy metals, Chemical composition, Carbonates, Sulfides, Organic compounds, Cadmium, Chromium, Nickel, Lead, Zinc, Fractionation.

Metals (Cd, Cr, Cu, Ni, Pb and Zn) have been fractionated in representative sewage sludges (primary, secondary, digested) by a sequential extraction procedure using KNO3 1M (removes the 'exchangeable' fraction), KF 0.5M ('sorbed'), Na4P2O7 0.1M ('organic'), Na2EDTA 0.1M ('carbonate') and HNO3 6M ('sulfide'). Major differences according to sludge type were not seen. Cd occurred mainly in the 'carbonate' fraction and 38-62% of Cr was in the 'organic' fraction. 43-70% Cu was in the 'sulfide' fraction while > 40% of Ni was extracted in the 'exchangeable/sorbed' fractions. Pb was found predominantly in the 'organic' and 'carbonate' fractions and Zn in the 'organic' fraction. The complete extraction procedure removed 54-100% of the total metals content of the sludges. Changes in fractionation caused by drying, storage and time of extraction are reported. The results form the first part of a detailed investigation into the chemistry of metals in sewage sludge. (Author's abstract)
W86-01184

SUNLIGHT PHOTOOXIDATION OF ORGANIC POLLUTANTS IN WASTEWATER,
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
A. J. Acher.
Water Science and Technology, Vol. 17, No. 4/5, p 623-632, 1985. 5 Fig, 5 Tab, 22 Ref.

Descriptors: *Solar irradiation, *Wastewater treatment, *Photooxidation, Dye-sensitizers, Organic matter, Surfactants, Disinfection, Bacteria, Viruses, Algae, Uracil, Triazine, Anilides, Detoxification, Water reuse.

The material presented represents results of a research on a new method for using solar energy for municipal and industrial wastewater treatment. This research seeks to develop economical methods of disinfection and detoxification of wastewaters which would result in the reuse of effluents for crop irrigation. Aerated effluents containing dye-sensitizers were exposed to solar irradiation for various periods of time. The influence of the solar energy, absorbed by these sensitizers in the visible range, on the organic matter and anionic surfactants (MBAS) in secondary effluents was checked by determining the COD and MBAS values of treated wastewater. The disinfection potential of this method was followed by bacteriological analyses of running water or secondary effluents, previously contaminated or enriched, respectively, with laboratory cultures of E. coli, bacteriophages (coliphage X and F2) and polio virus (type L-Sc 1). The influence of this photooxidative method was also studied in eutrophic algae present in the Lake of Galilee. It was found that the conditions under which disinfection proceeds also support algicidal processes, causing lethal damage to algal cultures. Further investigations on stable pesticides (uracil, s-triazine and anilide derivatives) in surface water or industrial wastewater showed that such a method can also be used for detoxifying pesticides in these waters. (Author's abstract)
W86-01187

SYNTHESIS MODELING OF MUNICIPAL WASTEWATER TREATMENT SYSTEMS,
Universidade Nova de Lisboa (Portugal). Sanitary Engineering Group.
A. S. Camara, C. W. Randall, and L. C. Frair.
Water Science and Technology, Vol. 17, No. 4/5, p 633-644, 1985. 2 Fig, 2 Tab, 14 Ref.

Descriptors: *Wastewater treatment, *Optimization, *Model studies, Economic aspects, Costs, Engineering, Tertiary treatment, Efficiency.

The synthesis of wastewater treatment systems refers to the specification of both a system structure, the choice and arrangement of unit processes and operations, and the design of the individual units within that structure so that a set of economic and environmental objectives is fulfilled. Synthesis models allow one to define the minimal cost design for a wastewater treatment system, specifying the system structure and the design of the individual units within that structure. There are still important limitations on cost and engineering data which do not permit a truly optimal design of treatment plants. The major problems in the cost information occur in the tertiary treatment stage. Most of the cost functions of tertiary treatment units are expressed in terms of the plant flow rate and are therefore not related to design variables. As a result, one can not determine optimal dimensions for those units. The main deficiencies in the engineering information are basically in three areas: removal efficiency values for pollutants for most of the tertiary units and some of the secondary units; definition of quantitative relationships between the efficiency of the thickening units and the subsequent digesting and dewatering units; and computation of supernatant flow rate and concentrations. Despite these limitations, it is possible to develop a synthesis model representing an improvement over the available synthesis models. The treatment plant can be considered as a network with loose connections. These weak links allow one to divide it into sub-networks. The synthesis problem is then divided into sub-problems connected by 'tear contraints' (on to each sub-network) and solved using known optimization methods. (Moore-IVI)
W86-01188

F SPECIFIC RNA BACTERIOPHAGES IN SEWAGE: METHODOLOGY AND OCCURRENCE,
Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands). Lab. voor Zoonosen Lebensmittelmikrobiology.
For primary bibliographic entry see Field 5A.
W86-01189

TREATMENT OF AGRO-INDUSTRIAL WASTES USING WATER HYACINTH,
Rubber Research Inst. of Malaya, Kuala Lumpur (Malaysia).
C. K. John.
Water Science and Technology, Vol. 17, No. 4/5, p 781-790, 1985. 3 Fig, 4 Tab, 14 Ref.

Descriptors: *Water hyacinth, *Biological wastewater treatment, *Industrial wastewater, Malaysia, Rubber industry, Palm oil mill effluent, Wastewater treatment, Wastewater lagoons.

In Malaysia lagoon systems have been successfully adopted by the natural rubber (NR) and oil palm industries to treat their effluents. The possibility of using Eichhornia crassipes (water hyacinth) in the lagoons to further improve the treatment system was investigated. Good removal of pollutants from the block rubber effluent was achieved using a hydraulic retention of 10 - 15 days. The resulting effluent discharge was of acceptable quality. Water hyacinth also markedly improved the quality of the effluent from the remilling rubber factories. Consequently propagation of water hyacinth in the lagoons has been recommended. Pilot plant trials with palm oil mill effluent (POME) have shown that water hyacinth can be successfully grown in anaerobically digested liquor removing 96% BOD, 87% COD, 96% suspended solids, 83% ammoniacal nitrogen and 97% oil and grease. It also removed more than 99% of the indicative bacteria such as coliforms, Escherichia coli and Streptococci. Under the Malaysian conditions, water hyacinth grew profusely yielding about 500 kg of dry matter per ha per day. The average dry weight was about 5.0% and it contained about 24% protein, 21% fiber and 14% ash. (Author's abstract)
W86-01200

SELECTIVE CULTIVATION OF EASILY HARVESTABLE ALGAE USING CROSSFLOW-MICROSCREENING,
Pretoria Univ. (South Africa). Dept. of Water Utilisation Engineering.
W. A. Pretorius, and L. C. Hensman.
Water Science and Technology, Vol. 17, No. 4/5, p 791-802, 1985. 14 Fig, 1 Tab, 15 Ref.

Descriptors: *Biological wastewater treatment, *Algae, *Crossflow-microscreening, Biomass, Stigeoclonium, Wastewater treatment, Algal harvesting.

The implementation of algal systems as a viable wastewater treatment option has been seriously limited by the availability of cost effective techniques for removing algae from the effluent stream. In this study, the problem of biomass separation was overcome by the selective cultivation of algae species which could be removed effectively by simple screening. The selection of desired species was achieved by a combination of short hydraulic space time and various size microscreens operating as algae selectors on the effluent stream. A high rate algae growth system, in which the mean cell residence time and hydraulic space time could be manipulated independently, was developed. With humus tank effluent as feedstock, a hydraulic space time of 10 hours and a 200 micro-m opening size crossflow-microscreen, the filamentous green algae, Stigeoclonium, became the dominant species. This selected culture could be readily maintained at any predetermined concentration in the system with less than 20 mg/l suspended solids in the effluent. The biomass produced was exceptionally easy to harvest. (Author's abstract)
W86-01201

WASTE WATER RECYCLING BY DUCKWEED FOR PROTEIN PRODUCTION AND EFFLUENT RENOVATION,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
G. Oron, L. R. Wildschut, and D. Porath.
Water Science and Technology, Vol. 17, No. 4/5, p 803-817, 1985. 6 Fig, 4 Tab, 31 Ref.

Descriptors: *Wastewater renovation, *Duckweed, *Biological wastewater treatment, Water reuse, Aquaculture, Wastewater ponds, Biomass production, Arid areas, Evaporation.

The success of a wastewater recycling system ultimately depends upon the quality of the renovated effluent, mainly for irrigation in dry areas, and on the quality and quantity of the additional by-prod-

ucts accepted. The simultaneous treatment of wastewater and the production of duckweed in a pond system, as an alternative protein source, is an attractive proposition for solving the feed and water shortage problem in arid areas. Outdoor experiments conducted in mini-ponds showed that duckweed ponds may be highly competitive with existing secondary treatment methods. Duckweed systems for secondary wastewater treatment can be highly productive with a biomass yield of 8 to 15 g/sq m per day (dry weight) and crude protein content in the range of 30 to 45% of the dry weight. The ease of the duckweed harvesting makes the system even more economically attractive, and the amino acid composition of the duckweed makes it a good alternative protein source. The removal efficiency of the major pollutants reaches 50 to 60%. The duckweed pond systems are superior to other wet free surface waste treatment methods in regards to water losses. At least 30% of water loss due to evaporation in other wet processes can be saved in duckweed ponds. In areas with limited water sources, this aspect is essential. (Moore-IVI)
W86-01202

POTENTIAL TREATMENT ALTERNATIVE FOR SWINE WASTEWATER IN THE TROPICS,
Hawaii Univ. at Manoa, Honolulu. Dept. of Agricultural Engineering.
P. Y. Yang, and S. Y. Nagano.
Water Science and Technology, Vol. 17, No. 4/5, p 819-831, 1985. 7 Fig, 9 Tab, 14 Ref. EPA grant R-808056.

Descriptors: *Animal wastes, *Tropical areas, *Biological wastewater treatment, Anaerobic digestion, Algal biomass raceway, Methane, Wastewater management, Energy production.

Development of a low-cost and effective swine waste management system in the tropics is the main objective of this study. Because of the appropriate temperature environment and abundance of sunlight, an integration of an anaerobic digestion and an algal biomass process was selected and investigated. A pilot plant integrating a 20 cu m anaerobic digester with sludge recycling and a 120 cu m algal-biomass raceway were installed and evaluated. Maximum gas production rate of 1.527 liter/liter/day (69% methane content) can be achieved by the total volatile solids (TVS) loading rate of 4.23 gram/liter/day. A sludge production rate of 0.82-2.62 g total solids/liter is obtained from a TVS loading rate of 0.76-4.23 g TVS/liter/day. Critical solids retention time for maximum gas production rate is 2.67. For the algal biomass raceway, a loading rate of 0.097 g soluble COD/liter/day or 0.017 g NH4-N/liter/day would achieve soluble COD and NH4-N removal efficiencies of 94.44% and 98.42%, respectively. Combining the previous analysis of energy input and land requirement for an algal biomass raceway and mass balance of energy production and utilization, integrating the energy production (anaerobic digestion) and energy utilization (dehydration of digested sludge and power requirement of raceway) provides a great potential for a swine wastewater treatment in the tropics. (Author's abstract)
W86-01203

HAZARDOUS SUBSTANCES IN WASTE WATER,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
A. B. van Luin, and W. van Starkenburg.
Water Science and Technology, Vol. 17, No. 6/7, p 843-853, 1985. 12 Tab, 8 Ref.

Descriptors: *Wastewater, *Effluent, *Sludge, *Hazardous substances, Hydrocarbons, Industrial wastewater, Municipal wastewater, Volatile compounds, Chlorinated hydrocarbons, Aromatic compounds, Water pollution sources, Wastewater treatment.

The influent, effluent and sludge of six municipal wastewater treatment plants and wastewater from 59 industries were sampled and analyzed for hazardous substances. Volatile chlorinated hydrocarbons in sewage seem to originate mostly from industrial emissions. The amount of the emissions can fluctuate very strongly especially for dichloromethane and 1,2-dichloroethane. Chlorophenols, hexachlorocyclohexane, polychlorinated biphenyls and polycyclic aromatic hydrocarbons are always present at a low basic level in municipal wastewater and in many industrial wastewater streams. In addition to point sources there are also diffuse sources like deposition from the air and road traffic which are responsible for extra pollution of sewage. Volatile chlorinated hydrocarbons in sewage originate mainly from industrial discharges. Chlorophenols, hexachlorocyclohexane, polychlorinated biphenyls and polycyclic aromatic hydrocarbons appear to be present at a low and constant background in municipal sewage and in mainly industrial waste waters. The removal in the municipal treatment plants amounts to: volatile chlorinated hydrocarbons 50-90%; hexachlorobenzene 95%; hexachlorocyclophexanes 40-65%; chlorophenols 20-40%; PCB about 90%; PAH 85-95%. (Moore-IVI)
W86-01225

STABILIZATION OF ORGANIC CARBON AND NITROGEN IN CONSOLIDATING BENTHAL DEPOSITS,
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
C. W. Bryant, Jr, and L. G. Rich.
Water Science and Technology, Vol. 17, No. 6/7, p 929-940, 1985. 5 Fig, 4 Tab, 27 Ref.

Descriptors: *Organic carbon, *Nitrogen, *Stabilization, *Benthal deposits, Mathematical models, Simulation, Biodegradation, Activated sludge, Volatile compounds, Organic loading, Wastewater lagoons.

The objective of this research was to develop and validate a predictive model of the benthal stabilization of organic carbon and nitrogen in deposits of waste activated sludge solids formed at the bottom of an aerated water column, under conditions of continual deposition. A benthal model was developed from a one-dimensional, generalized transport equation and a set of first-order biological reactions. For model verification, depth profiles of the major interstitial carbon and nitrogen components were measured from a set of deposits formed in the laboratory at 20 C and a controlled loading rate. The observed sequence of volatile acid utilization in each benthal deposits was that which would be predicted by the Gibbs free energies of the individual degradation reactions and would be controlled by the reduction in interstitial hydrogen partial pressure with time. Biodegradable solids were solubilized rapidly during the first three weeks of benthal retention, but subsequent solubilization occurred much more slowly. The benthal simulation effectively predicted the dynamics of consolidating, organic deposits. Simulation of organic loading rates up to 250 g biodegradable volatile suspended solids/(sq m day) indicated that the stabilization capacity of benthal deposits was far above average the range of organic loading rates currently used in lagoon design. (Author's abstract)
W86-01232

ORGANIC REMOVAL MECHANISMS IN BIOPHYSICAL TREATMENT SYSTEMS,
Utah Univ., Salt Lake City. Dept. of Civil Engineering.
J. R. Schultz, and T. M. Keinath.
Water Science and Technology, Vol. 17, No. 6/7, p 1043-1054, 1985. 8 Fig, 1 Tab, 27 Ref.

Descriptors: *Biophysical treatment, *Phenols, *Organic compounds, Biodegradation, Bioregeneration, Adsorption, Activated carbon, Desorption, Wastewater treatment.

An experimental program was conducted to evaluate the significance of enhanced biodegradation, bioregeneration, and metabolic end product (MEP) adsorption in a bench-scale biophysical reactor using phenol as the substrate. Radiotracer methods and a desorption-extraction procedure that measures the amount of adsorbed phenol were used to discriminate between the various mechanisms. The results showed the major benefit of powdered activated carbon (PAC) addition under steady-state conditions to be MEP adsorption. Furthermore, adsorption reversibility was established as the controlling mechanism for bioregeneration. Reversibly adsorbed phenol could be desorbed to regenerate the PAC, but irreversibly MEP could not. PAC, therefore, acts as a storage reservoir during shock loads via an adsorption-desorption sequence. (Author's abstract)
W86-01240

OZONATION OF NON-IONIC SURFACTANTS IN AQUEOUS SOLUTIONS,
Technion - Israel Inst. of Tech., Haifa. Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 5F.
W86-01242

INFLUENCE OF BUBBLE SIZES ON OZONE SOLUBILITY UTILIZATION AND DISINFECTION,
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Civil Engineering.
M. Ahmad, and S. Farooq.
Water Science and Technology, Vol. 17, No. 6/7, p 1081-1090, 1985. 6 Fig, 3 Tab, 11 Ref.

Descriptors: *Bubble size, *Ozone, *Disinfection, *Solubility, Microorganisms, Effluents, Ozonation, Wastewater treatment, Bacteria.

A disinfection study was carried out with the natural bacterial population of a secondary treated wastewater effluent in a continuous flow system employing different sizes of ozone bubbles to determine their effects on solubility of ozone, its utilization and inactivation of microorganisms. The bubble sizes were varied by changing the porosity of the diffusers and ozone flow rates through the ozone contactor. Natural bacterial population (standard plate counts) present in the secondary wastewater effluent was enumerated before and after ozonation. The concentration of ozone in the aqueous phase increases with a decrease in the size of the ozone bubble for a given gas flow rate, provided the ozone concentration remains constant in the gas phase. The amount of ozone utilized by wastewater decreases proportionally with the size of the ozone bubbles for the same gas flow rate and for the same level of disinfection. For a given gas flow rate and ozone residual, the degree of inactivation of microorganisms increases as the size of ozone bubbles decreases. (Moore-IVI)
W86-01243

MANAGEMENT OF URBAN WASTE WATER PHYSICO-CHEMICAL TREATMENT STATIONS: SERVOCONTROL OF REAGENT ADDITIONS AT THE QUIBERON SEWAGE TREATMENT PLANT, FRANCE,
Laboratoire Central des Ponts et Chaussees, Bouguenais (France).
P. Marchandise, J. P. Legendre, D. Delacroix, and J. L. Rivoal.
Water Science and Technology, Vol. 17, No. 6/7, p 1103-1112, 1985. 9 Fig, 2 Tab, 2 Ref.

Descriptors: *Wastewater treatment, *Turbidity, *Automation, Physico-chemical treatment, Servocontrol, Reagents, Quiberon, France.

The physico-chemical treatment of sewage calls for the use of quantities of reagents commensurate with the pollution to be eliminated. The use of a servocontrol makes it possible to add reagent according to pollutant content and to achieve a degree of pollution control chosen in advance. Tests were carried out to determine turbidity-COD-suspended matter relations in wastewater samples, and flocculation tests were used to determine treatment effectiveness curves for ferric chlorosulfate. In this system, turbidity is continuously measured, using the Monitek turbidimeter. The voltage delivered by the turbidimeter is integrated by a logarithmic amplifier in accordance with the effectiveness curve chosen and multiplied by the flowrate information; this controls the ferric chlorosulfate metering pump. The installation of the servocontrol module at the treatment plant of

Quiberon, France, for the 1983 tourist season provided an opportunity for a full-scale test of the effectiveness of the system. The reliability of the system was demonstrated. For equivalent treatment at this 40,000 population-equivalents plant, the investment was amortized in one season's operation. (Moore-IVI)
W86-01244

MODELLING OF THE COAGULATION-ADSORPTION PROCESS IN TREATMENT SYSTEMS,
Wroclaw Technical Univ. (Poland). Inst. of Environment Protection Engineering.
For primary bibliographic entry see Field 5F.
W86-01245

COLLECTION AND ANALYSIS OF URBAN RUNOFF DATA IN FINLAND,
National Board of Waters, Helsinki (Finland). Technical Research Office.
M. J. Melanen.
Water Science and Technology, Vol. 17, No. 6/7, p 1175-1185, 1985. 12 Tab, 9 Ref.

Descriptors: *Urban runoff, *Pollution load, *Finland, Precipitation, Hydrology, Nutrients, Organic matter, Paving, Storm wastewater.

An extensive three-year urban hydrology program was carried out in Finland. Data were collected and analyzed on the quantity and quality of precipitation and runoff water at seven urban test catchments. During rainfall events, on the average, the proportion of surfaces generating direct runoff was found to account for 50-80% of the proportion of paved surfaces in the residential catchments, and for 80-90% in the city centers. Under Finnish conditions, the pollutant loads discharged to recipients with untreated runoff waters are relatively minor in comparison to those of purified waste waters, regarding organic matter and nutrients. Further measures in the Finnish sewage works should thus be focused on other factors, such as increasing the effectiveness of the existing waste water treatment plants, and decreasing the amount of leakage inflows to sewer networks. (Author's abstract)
W86-01251

SEDIMENTATION, MINERALIZATION AND RESUSPENSION OF SLUDGE IN A SEWERAGE SYSTEM: A CASE STUDY,
Witteveen and Bos, Deventer (Netherlands).
A. S. Hogendoorn-Roozemond.
Water Science and Technology, Vol. 17, No. 6/7, p 1223-1231, 1985. 7 Fig, 3 Tab, 1 Ref.

Descriptors: *Sedimentation, *Mineralization, *Resuspension, *Sewer systems, Combined sewer overflows, Organic matter, Temperature effects, Weather, Seasonal variation.

The design of combined sewerage systems allows a certain frequency of overflows, but it is difficult to quantify the pollution load from these sewer overflows adequately. Sedimentation and mineralization in a sewerage system together with resuspension of organic matter, which often becomes evident in first flush phenomena. Quantitative information was obtained on the processes of sedimentation, mineralization and resuspension of organic matter in a combined sewerage system by means of statistical analysis of dry and wet weather data on sewage flows. The effects of temperature and length of intermittent dry weather periods on daily pollutant loads were also evaluated. For the sewerage system investigated it was found in summer 5-26% of the BOD produced is mineralized in the system before reaching the sewage treatment plant. Deposition and mineralization of organic matter take place simultaneously. Models predicted that a steady state situation was attained after 5-7 days in the summer and 7-11 days in the winter. Due to sedimentation under dry weather conditions up to 12% of the daily organic load produced may be present in the sewers as resuspendable deposits; in winter this percentage may even amount to 20-30% because of slow mineralization. These conclusions are only valid for the sewerage system studied. (Moore-IVI)
W86-01255

POSSIBILITIES FOR USE OF LOWER GREEN AND BLUE-GREEN ALGAE IN THE ANIMAL FARMS WASTE WATER TREATMENT IN BULGARIA (V'ZMOZHNOSTI ZA IZPOLZVANETO NA NISSHI ZELENI I SINO-ZELENI VODORASLI V PRECHISTVATELNIYA PROTSES NA OTPAD'CHNITE VODI OT ZHIVOTNOV'DNITE KOMPLEKSI V B'LGARIYA),
K. M. Benderliev.
Hydrobiology, Vol. 23, p 9-14, December, 1984. 1 Tab, 6 Ref.

Descriptors: *Wastewater treatment, *Bulgaria, *Algae, *Cyanophyta, *Animal wastes, Feedlot wastes, Proteins, Water treatment, Fish ponds.

On the basis of original and reference data the possibilities for the use of green and blue-green algae in waste water purification in the Bulgarian climatic, demographic and economic conditions are pointed out and their economic effectivity is evaluated. The construction of aerobic algal oxidative pools either followed by, or not followed by, fish pools is recommended. Both should not be considered as water cleaning devices, but rather as protein recycling devices. For the time being, the construction of intensive algal ponds is not recommended. (Author's abstract)
W86-01259

FACTORS INFLUENCING THE OZONE INACTIVATION OF ENTERIC VIRUSES IN EFFLUENT,
Stanford Univ., CA. Dept. of Medical Microbiology.
M. S. Harakeh, and M. Butler.
Ozone: Science and Engineering, Vol. 6, No. 4, p 235-243, 1984. 9 Fig, 25 Ref.

Descriptors: *Ozonation, *Wastewater treatment, *Viruses, *Enteroviruses, *Disinfection, Water chemistry, Water treatment, Ozone, Ultrasonic treatment, Hydrogen ion concentration, Bicarbonate, Sodium bicarbonate, Hydroxide, Microorganisms.

Studies on ozonation of effluent for inactivation of viruses are limited and little is known about the range of conditions which influence the efficacy of ozone; the published work has been restricted to only a few enteroviruses. In experiments with the enteroviruses, polio type 1 (LSc 2ab), coxsackie B5 and echo 1, human rotavirus, simian rotavirus SA11, and f2 coliphage, inactivation kinetics with continuously applied ozone were approximately exponential with respect to time and concentration. The most resistant of the tested viruses was human rotavirus and the most sensitive was f2 coliphage. The disinfectant was most reactive at low pH. Viral sensitivity was increased ten-fold in the presence of 0.5M sodium bicarbonate which supports the hypothesis that it was molecular O3 that was the most active molecule and not the OH radical. Neither temperature, the presence of added peptone nor suspended solids greatly influenced inactivation, but ultrasonic treatment did, whether applied before or during ozonation. It has been postulated that when ozone hydrolyzes in water, about half of it will be converted to OH radicals, the most reactive oxidant known, with the rate of the hydrolysis dependent on the concentration of ozone, the pH, and the concentration of carbonate and bicarbonate ions. Hydrolysis is accelerated by raising the pH since the formation of the OH radical is favored at alkaline pH values but is inhibited by carbonate/bicarbonate which scavenge the radical in some way which is yet to be fully elucidated. The mechanism of inactivation by ozone is little understood; whether or not all viruses would be inactivated in a similar way remains to be determined, but it is very likely that even amongst the robust enteric viruses differences would be observed, although in practice these may not be relevant. (Collier-IVI)
W86-01268

HIGH TEMPERATURE TREATMENT OF TRINITROTOLUENE (TNT) AND CYCLOTRIMETHYLENE-TRINITRAMINE (RDX) WITH OZONE AND ULTRASOUND,
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
R. A. Sierka.
Ozone: Science and Engineering, Vol. 6, No. 4, p 275-290, 1984. 2 Fig, 8 Tab, 14 Ref.

Descriptors: *Trinitrotoluene, *Wastewater treatment, *Water temperature, *Ozone, *Ultrasound, *Cyclotrimethylene-Trinitramine, Water treatment, Munitions industry, Industrial wastewater.

Treatment of synthetically prepared aqueous solutions of trinitrotoluene (TNT) and cyclotrimethylene-trinitramine (RDX) in the weight ratio 70%/30%, representing a typical munitions wastewater, was researched with a combination of ozonation and ultrasound. A parametric study investigated the relationship among the variables: (1) initial solution pH (5.84 to 10.0); (2) ultrasound power level (5 to 50 watts at 852.0 to 863.0 kHz); (3) ultrasound frequency level (60.6 to 1,007.0 kHz); (4) solution concentration (70/30 mg/l TNT/RDX solutions volumetrically diluted with distilled water in the ratios 1/0, 1/3); (5) reaction temperature (25 to 59 C). Removal rates of both TNT and TOC increased directly with increases in reaction temperature and initial solution pH. Likewise, increased sound power level produced enhanced system kinetic responses; however, these were attributed to reaction mass temperature increases. Ultrasound was found to inhibit reaction kinetics at high temperatures and pH because it promoted radical-radical extinguishment reaction. (Author's abstract)
W86-01271

APPLICATION OF ACUTE BIOASSAYS IN EVALUATING THE TREATMENT OF COAL LIQUEFACTION WASTEWATERS,
Department of Energy, Pittsburgh, PA. Pittsburgh Energy Technology Center.
T. J. Feeley, III, and C. J. Drummond.
Bulletin of Environmental Contamination and Toxicology, Vol. 35, p 249-257, August, 1985. 2 Fig, 2 Tab, 13 Ref.

Descriptors: *Bioassays, *Toxicity, *Coal liquefaction wastewater, *Wastewater treatment, Evaluation, Gas stripping, Ammonia, Biochemical oxygen demand, Solvent extract, Toxicity, Oxidation.

Acute bioassays were performed on untreated coal liquefaction process wastewater and the wastewater following a series of treatment steps to determine the applicability of acute toxicity tests in evaluating the effectiveness of an integrated wastewater treatment strategy and selected treatment unit operations in reducing the contaminants present in the wastewater. The first step of the integrated treatment train, dissolved gas stripping, was responsible for a significant reduction in the total ammonia present in the wastewater. The largest reductions in acute toxicity were recorded after solvent extraction of the wastewater and after biochemical oxidation. The overall decrease in acute toxicity was due to significant reductions in both the inorganic and the organic contaminants present in the untreated wastewater, although the organics, specifically phenols, may play a more dominant role. Dissolved gas stripping and wet air oxidation were each performed on the untreated wastewater. Dissolved gas stripping removed the bulk of the total ammonia and sulfide from the wastewater but had little impact on the organic components and resulted in a 48 hr EC50 of only 0.12%. Wet air oxidation, on the other hand, appreciably reduced phenols, TOC, and BOD. The 48-hr EC50 of the wet air oxidized effluent was only 0.34% and probably reflects the high total ammonia remaining in the wastewater. The relatively small reductions in acute toxicity recorded after either of these two unit operations emphasize the importance of an integrated treatment program that removes both the inorganic and the organic contaminants from the wastewater. (Baker-IVI)
W86-01284

COUNTY RESTORES GROUNDWATER AQUIFER,

Fresno County Public Works Dept., CA.
For primary bibliographic entry see Field 5G.
W86-01314

5E. Ultimate Disposal Of Wastes

MULTI-OBJECTIVE DECISION-MAKING IN WASTE DISPOSAL PLANNING,
Oak Ridge National Lab., TN.
R. D. Perlack, and C. E. Willis.
Journal of Environmental Engineering, Vol. 111, No. 3, p 373-385, June, 1985. 1 Fig, 2 Tab, 17 Ref, 1 Append.

Descriptors: *Decision making, *Planning, *Sludge disposal, Waste disposal, Incineration, Land disposal, Ocean dumping, Economic aspects, Environmental effects, Cluster analysis, Multi-objective planning.

Ocean disposal is the present mode of disposal of the Metropolitan Boston (Massachusetts) sewage sludge; incineration and land application are alternatives being considered. A multiple objective programming model of the Boston sludge disposal problem was formulated in which the objectives of net economic benefits, environmental impact, and variability of impacts were included. A generating technique is used to solve for the noninferior solutions and cluster analysis is applied to reduce redundancy among generated solutions. The end result of this analysis is an array of possible solutions to the disposal problem, none of which are unambiguously superior. On the basis of cost, the ocean disposal solutions are clearly superior, while the solutions involving multiple disposal modes are the most expensive. Agricultural land application is somewhere in between. The reverse is true for the environmental impact objective, with land application again occupying the middle ground. An array of results such as this is likely to be more valuable to decision-makers than requiring them to articulate their conception of the social preference function (in advance of knowledge of the complete solution space), and then presenting them with a single optimum solution. This technique provides the maximum quantity of information to the decision-maker. (Moore-IVI)
W86-01044

CONTROLLING METAL UPTAKE FROM HEAT-TREATED SLUDGE APPLIED TO GRASSLANDS,
Port Elizabeth City Engineer's Dept. (South Africa).
J. W. Vail, and D. G. Devey.
Water Science and Technology, Vol. 17, No. 4/5, p 599-610, 1985. 6 Tab, 23 Ref.

Descriptors: *Metals, *Grasslands, *Sludge disposal, *Land disposal, Zinc, Nickel, Lead, Chromium, Pastures, Turf, South Africa, Standards.

A Zimpro heat-treated sewage sludge containing high levels of zinc, nickel, lead and chromium was successfully used to establish high-grade pastures and turf on two different coastal soils in South Africa, using guidelines and developed in the United Kingdom to control the rate of application. The properties and composition of the sludge and soils are described and levels of metals in the grass are reported. The rates of application suggested by the guidelines were effective in preventing excessive metal uptake. The results obtained are discussed in relation to tentative guidelines for controlling sewage sludge applications to land in South Africa. (Author's abstract)
W86-01185

STRUCTURAL FEATURES OF THE GREY-BROWNISH BLACK SANDY SOILS OF APSHERON AND THEIR ALTERATION FOLLOWING APPLICATION OF WATER PIPE SLUDGE FROM KUZINSK (MIKROMORFOLOGICHESKIE OSOBENNOSTI SEROBURYKH PESCHANYKH POCHV APSHERONA I IKH IZMENENIE PRI VNESENII KURINSKOGO VODOPROVODNOGO OSADKA),
I. Sh. Iskenderon, and Sh. M. Shirinova.
Izvestiya Akademii Nauk Azerbaydzhanskoy SSR Seriya Biologicheskikh Nauk, No. 1, p 25-28, 1983. 1 Fig, 15 Ref.

Descriptors: *Apsheron, *Azerbaijan S.S.R., *Soil types, *Kuzinsk, *Land application, *Sludge utilization, Sludge disposal, Sandy soils, Physicochemical characteristics, Geochemistry, Agriculture.

To improve the morphology of the sandy soils of Apsheron, Azerbaijan S.S.R., for the cultivation of vegetables, experimental studies with increasing doses of water pipe sludge applied per hectare of ground were carried out. The control soil samples featured a loose structure due to the presence of coarse mineral grains with rare carbonized plant inclusions. The mineral constituent was basically of calcitic and feldspar nature and had no colloidal membranes. Carbonates and organic substances were the basic binding constituent and the soil was lacking microaggregation. The sludge used in this study was dark grey, featured a tight structure with fine grain calcite and rare single pores. Application of 5, 10, and 30 T/Ha improved the microstructure of the sandy soil with increasing dosage of sludge generating ground plasma and soil aggregation. (Erdelyi-IVI)
W86-01256

5F. Water Treatment and Quality Alteration

ELIMINATION OF THE WATER POLLUTANT 2,4-D THROUGH ADSORPTION BY ALUMINUM OXIDE (ZUR ELIMINATION DES WASSERSCHADSTOFFES 2,4-D DURCH ADSORPTION AN ALUMINIUMOXID),
Technische Univ., Dresden (German D.R.). Sektion Wasserwesen.
H.-J. Walther, and B. Wiemer.
Acta Hydrochimica et Hydrobiologica, Vol. 11, No. 6, p 679-682, 1983. 2 Fig, 6 Ref.

Descriptors: *Water treatment, *Dichlorophenoxyacetate, *Aluminum oxide, *Adsorption, Pesticides, Humic acids, Drinking water, Hydrogen ion concentration, Sulfates, Phosphates, Dissociation.

The influence of humic acids on the adsorption of the pesticide 2,4-D (2,4-dichlorophenoxyacetic acid, sodium salt) by aluminum oxide in the treatment of drinking water was investigated. Organic and inorganic anions are adsorbed by aluminum oxide; among the latter in particular, sulfate ions and phosphate ions. The adsorption rate rises with declining pH values. The dissociation constant of 2,4-D (free acid) is 0.0023 and is of the general order of the dissociation constant of salicylic acid. (Moore-IVI)
W86-01005

FLOW UNDER TILT SURFACE FOR HIGH-RATE SETTLING,
Osaka Univ. (Japan). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W86-01040

EXPRESSION FOR DRINKING WATER SUPPLY STANDARDS,
Roorkee Univ. (India). Dept. of Civil Engineering.
D. S. Bhargave.
Journal of Environmental Engineering, Vol. 111, No. 3, p 304-316, June, 1985. 5 Fig, 2 Tab, 6 Ref, 1 Append.

Descriptors: *Drinking water, *Water quality standards, Water quality index, Model studies.

Various authorities and regulating agencies have set standards for deciding the suitability of a water for drinking purposes. These standards prescribe the permissible concentrations of quality variables. When some variables exceed the permissible levels, a decision for permitting further use of the water supply has to be based on the importance of those variables with exceeded concentrations. It is proposed that standards for a drinking water supply should be set through a single number representing the integrated effect of all the variables, keeping due regard to the importance of each variable. Such an integrated water quality index (WQI) would help in decision making. Models and curves have been presented to evolve a WQI for drinking water supplies. It is suggested that water with a WQI lower than 90 should not be permitted. The acceptable quality therefore, should be in 90-100 range of the WQI. (Author's abstract)
W86-01041

REMOVAL OF PESTICIDES IN WATER BY MICROBIAL CELLS ADSORBED TO MAGNETITE,
Queensland Univ., Brisbane (Australia). Dept. of Microbiology.
I. C. Mac Rae.
Water Research, Vol. 19, No. 7, p 825-830, 1985. 3 Fig, 5 Tab, 24 Ref.

Descriptors: *Pesticides, *Microorganisms, *Sorption, *Magnetite, Lindane, 2,4-D, 2,4,5-T, Yeasts, Bacteria, Algae, Water treatment.

The removal of lindane (gamma-isomer of 1,2,3,4,5,6-hexachlorocyclohexane), 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) from water by microbial cells immobilized on magnetite was studied. The removal of lindane by cells of a yeast, two bacteria and an alga ranged from 29 to 57%. A bacterium, Rhodopseudomonas sphaeroides had the highest sorption factor. No effect of pH in the range pH 4.0-8.0 on sorption on lindane by this bacterium was found. Sorption of lindane by R. sphaeroides reached equilibrium after 1 min. Sorption of lindane by live cells was not significantly different from sorption by heat killed cells. Four sorption stages employing fresh cells of R. sphaeroides on magnetite removed 90% of the lindane from a water sample. Magnetite alone removed 70% of the lindane in four stage process. During a mixing period of 1 h, cells of Alcaligenes eutrophus removed 81% 2,4-D; 21.4% lindane and 12.6% of the 2,4,5-T added to water samples. A mixture of A. eutrophus and R. sphaeroides cells immobilized on magnetite removed 76.4% 2,4-D and 33% lindane from water samples containing the two pesticides. (Author's abstract)
W86-01057

DISINFECTION OF CIRCULATING WATER SYSTEMS BY ULTRAVIOLET LIGHT AND HALOGENATION,
Medical Coll. of Pennsylvania, Philadelphia.
R. W. Gilpin, S. B. Dillon, P. Keyser, A. Androkites, and M. Berube.
Water Research, Vol. 19, No. 7, p 839-848, 1985. 2 Fig, 10 Tab, 40 Ref.

Descriptors: *Disinfection, *Ultraviolet radiation, *Chlorination, Water treatment, Cooling water, Whirlpools, Hot tubs, Legionella, Pseudomonas, Public health.

Continuous ultraviolet light (u.v.) and chemical disinfection of circulating water systems were evaluated. Direct comparisons of the biocidal effectiveness of u.v. light vs halogenation were tested with Legionella spp. and Pseudomonas aeruginosa because of their association with the acquisition of overt clinical disease from water-containing appliances. Findings indicated that six species of Legionella and P. aeruginosa were killed by a moderate level of u.v. radiation. L. pneumophila and other bacteria in a circulating water system were effectively killed by a biocidal u.v. light. However, free chlorine levels needed to kill Legionella, Pseudomonas, and Flavobacterium within 1 min were found to be greater than 4 mg/ml. Data from a long-term field trial with u.v. light treatment of evaporative condensor water showed a significant reduction numbers of bacteria. Ultraviolet disinfection of hospital hydrotherapy whirlpools confirmed the utility of this mode of disinfection under circumstances where chlorination may not be practical for medical reasons. These findings were confirmed during investigations of halogenated or u.v.-treated public hot tub/whirlpools. The effectiveness of routine chemical disinfection for controlling microbial flora in a cooling tower was also

evaluated. The 2 month survey indicated that the numbers of bacteria, including Legionella, were not affected by two biocides that were used. The observations made during this investigation support the conclusion that u.v. light disinfection of water-containing systems may be an appropriate alternative or supplement to chemical biocides. (Author's abstract)
W86-01059

EFFECTS OF ACTIVATED CARBON ON THE REACTIONS OF COMBINED CHLORINE WITH PHENOLS,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
E. A. Voudrias, R. A. Larson, and V. L. Snoeyink.
Water Research, Vol. 19, No. 7, p 909-915, 1985. 3 Fig, 6 Tab, 22 Ref. NSF grant CEE 81-10024.

Descriptors: *Activated carbon, *Monochloramine, *Phenols, Water treatment, Chlorinated phenols, Polychlorinated biphenyls, Prechlorination, Drinking water, Chlorination.

In the presence of ammonia, prechlorination in drinking water treatment results in contact of combined chlorine (monochloramine) with activated carbon, which is used to remove organic compounds from water. Monochloramine reacts very slowly with phenolic compounds in aqueous solution, giving low yields of chlorinated phenols. When monochloramine reacts with phenols adsorbed on granular activated carbon (GAC), however, several oxidized products, principally hydroxylated biphenyls, are formed. Some of the hydroxylated biphenyls are chlorinated (hydroxylated PCBs). Their formation is particularly important because of their potential toxicity. Such compounds are major reaction products from chlorophenol, but they are also formed in small amounts from nonchlorinated phenols. Most of the monochloramine-GAC-phenolic compound reaction products are also produced in similar reactions with free chlorine, indicating that similar reaction mechanisms) take place on carbon's surface. No organic compounds are produced from the reaction of monochloramine with GAC alone. (Author's abstract)
W86-01066

COMPUTERIZATION CAN BOOST UTILITY PERFORMANCE,
Cincinnati Univ., OH. Dept. of Mechanical and Industrial Engineering.
R. L. Snell, and N. A. Damachi.
Water Engineering and Management, Vol. 132, No. 6, p 30-33, June, 1985. 2 Fig, 2 Tab, 6 Ref.

Descriptors: *Water management, *Computers, *Utilities, Decision making, Data processing, Water quality, Drinking water, Costs.

Alternative approaches available to most water utilities for acquiring computer services include: sharing a computer system with other muncipal agencies, or acquiring an independent computer system dedicated to the water utilty for administrative and operational functions. Some of the important constraints faced by water utilities include escalating costs for chemicals, labor and materials; increased energy costs; and stringent federal regulations and standards. Another constraint is the lack of trained personnel who posses adequate knowledge about computers and their cost, capabilities, and benefits. While implementation of a small computer based information system may impose some operational changes, these changes will facilitate operation and the flow of information. Improved and timely information retrieval at various management levels will enhance decision-making, resulting in improved utilization of manpower and other resources. Other potential benefits include the capabiliy to validate data to the degree desired for different functions and produce output reports with only valid information; and up to date budget reporting system and statement of operations; improvements in the efficiency and effectiveness of customer service to respond to queries and complaints; an improved inventory monitoring and control system; and facilitation of meeting mandated regulatory requirements for drinking water. (Baker-IVI)
W86-01084

STATE WATER SUPPLY MANAGEMENT IN NEW JERSEY,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 6C.
W86-01103

DETERGENTS FOR RESERVOIRS AND COLONY INCREASES IN POTABLE WATER (REINIGUNGSMITTEL FUR BEHALTER UND KOLONIEZAHL-ERHOHUNGEN IM TRINKWASSER),
Bonn Univ. (Germany, F.R.). Hygiene Inst.
V. D. Schoenen, and C. D. Godde.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 18, No. 3, p 121-123, June, 1985. 5 Fig, 1 Tab, 1 Ref.

Descriptors: *Maintenance, *Reservoirs, *Bacteria, *Detergents, Reservoir operation, Drinking water.

As a rule drinking water reservoirs are cleaned in one year intervals for which purpose special detergents are frequently used. After such cleaning an increase of colony counts has been observed again and again. Up to now however it has not become clear whether the detergents have an influence on this result. In a laboratory examination 5 detergents were tested by cleaning cement mortar and high-grade steel plates. After the purification of the cement mortar plates 4 of the 5 materials examined showed an increase of colony counts and of TOC in the water. Examination of the high-grade steel plates did not show either an increase of colony counts or a charge of TOC. (Author's abstract)
W86-01140

DISINFECTION OF DRINKING WATER RICH IN BROMIDE WITH CHLORINE AND CHLORINE DIOXIDE, WHILE MINIMIZING THE FORMATION OF UNDESIRABLE BY-PRODUCTS,
Hadassah Medical School, Jerusalem (Israel). Environmental Health Lab.
C. Rav-Acha, A. Serri, E. G. Choshen, and B. Limoni.
Water Science and Technology, Vol. 17, No. 4/5, p 611-621, 1985. 4 Fig, 4 Tab, 21 Ref.

Descriptors: *Drinking water, *Disinfection, *Bromides, *Chlorination, *Chlorine dioxide, Trihalomethanes, Chlorite, Halogenated hydrocarbons, Chemical reactions, Water treatment.

Although chlorine dioxide does not form trihalomethanes (THM) and produces very few non-volatile haloorganic materials in drinking water, intensive investigations bearing on the formation of chlorite by ClO2 disinfection reveal that the rate of chlorite formation reflects the rate of ClO2 consumption and as long as the amount of ClO2 applied is behind its demand, about 60% of the chlorine dioxide consumed is converted into chlorite. Mixtures of Cl2 and ClO2, which may successfully reduce the formation of haloorganic compounds, as well as of chlorite in the absence of bromide, fail to do this where water rich in bromide is concerned. As a result of bromide oxidation by chlorine, bromine is formed, which in turn reacts more intensively with organics than does chlorine and thus favors the formation of THM and other halogenated organic materials. This problem can, however, be circumvented if ClO2 is allowed to react in water with the organic precursors before chlorine is introduced. A pre-treatment with 1 ppm of ClO2 two hours before the application of 2 ppm Cl2, was found to reduce the formation of THM by 60% relative to its formation by chlorine alone, and the chlorite is reduced in this case by up to 90% relative to its formation by chlorine dioxide alone. This is of particular importance since it can solve some of the major problems bearing on the impact of disinfection upon the formation of undesirable by-products. (Author's abstract)
W86-01186

OCCURRENCE OF VIRUSES IN TREATED DRINKING WATER IN THE UNITED STATES,
Health Effects Research Lab., Cincinnati, OH.
E. W. Akin.
Water Science and Technology, Vol. 17, No. 4/5, p 689-700, 1985. 3 Tab, 30 Ref.

Descriptors: *Viruses, *Drinking water, Water treatment, Surface waters, Public health, Enteroviruses.

Health concerns regarding waterborne transmission of enteric viruses began to develop around 1940 in the U.S. with the isolation of poliovirus from human feces and sewage. The implication of these isolations for the transmission of viral disease through contaminated drinking water stimulated research on methodology for virus detection, recovery and assessment from water. Although virus methods research is still an important area of study, relatively sensitive procedures became available during the past decade for recovering many enteric virus types from large-volume samples of drinking water. Controversy surrounded many of the early reported isolations of viruses from treated drinking water using these procedures due to the suspicion of laboratory contamination. The occurrence of viruses in drinking water treated by currently accepted procedures has still not been proven by the U.S. experience although the likelihood may be gaining support. However, a virus survey of 54 water supplies and extensive studies of two water systems by the U.S. Environmental Protection Agency did not demonstrate viral contamination of treated water derived from surface sources. (Author's abstract)
W86-01193

OZONE ENHANCED BIOLOGICAL ACTIVATED CARBON FILTRATION AND ITS EFFECT ON ORGANIC MATTER REMOVAL, AND IN PARTICULAR ON AOC REDUCTION,
Studiesyndicaat voor Water, Antwerp (Belgium).
J. G. Janssens, J. Meheus, and J. Dirickx.
Water Science and Technology, Vol. 17, No. 6/7, p 1055-1068, 1985. 9 Fig, 7 Tab, 33 Ref.

Descriptors: *Activated carbon, *Filtration, *Ozonation, *Organic matter, Water treatment, Biodegradation, Organic compounds, Filtration, Biological treatment.

Ozonation of organic compounds in water usually produces oxygenated organic byproducts that are more readily biodegradable. Ozonation prior to granular activated carbon (GAC) filtration is evaluated in relation to organic matter removal, and in particular to AOC (assimilable organic carbon) reduction. Ozonation prior to GAC filtration resulted in a final water quality with generally a lower organic matter concentration. In terms of total organic carbon (TOC) removal, experimental results on pilot plant scale showed an increase of filter service time with about 60% to 65%. A dosage higher than 2 mg ozone/l had no additional effect. The extent to which this increase of service time was predominantly due to enhanced biological activity or to long term cumulative slow adsorption is not clear. An indicative economic analysis showed that the costs, as a result of ozonation, could not be covered by the cost-savings in reactivation of activated carbon. Ozonation caused a very significant increase of AOC. This was a function of the applied ozone dosage. Under equivalent conditions, GAC filtration of non-ozonated water gave the lowest AOC values in its effluent. First experimental results suggested a relation between ozonation and an early 'breakthrough' of AOC with GAC filters fed with ozonated water. If an AOC limit value is applied as a criterion for filter operating time, ozonation prior to GAC filtration would result in a significant shortening of the filter service time. (Moore-IVI)
W86-01241

OZONATION OF NON-IONIC SURFACTANTS IN AQUEOUS SOLUTIONS,
Technion - Israel Inst. of Tech., Haifa. Environmental and Water Resources Engineering.
N. Narkis, B. Ben-David, and M. S. Rotel.
Water Science and Technology, Vol. 17, No. 6/7,

p 1069-1080, 1985. 14 Fig, 2 Tab, 24 Ref.

Descriptors: *Surfactants, *Ozonation, Wastewater treatment, Water treatment, Organic carbon, Polyethylene glycol, Oxidation, Biodegradation.

The effect of ozone on dilute aqueous solutions of a series of non-ionic surfactants of nonyl phenol ethoxylates, with n = 4 to 30 ethylene oxide groups, dinonyl phenol ethoxylate and a polyethylene glycol were investigated. Assuming ozone concentration in solution to remain constant throughout the ozonation, the experiments showed first-order reactions with respect to surfactant concentration, as measured by the Wickbold method, and also with respect to COD and TOC. A linear relationship was established between the first-order reaction rate constants, and between n, the average number of ethylene oxide groups in the ethoxylate chain of the nonyl-phenol ethoxylate series. The oxidation mechanism by ozone of non-ionic surfactant molecules is explained as mainly polyethoxylate chain's cleavage into shorter polyethylene glycols and to a smaller extent oxidation of the aromatic ring. High ozone doses do not convert the non-ionic surfactant completely to CO2 and H2O but smaller doses are sufficient to enhance biodegradation. (Author's abstract)
W86-01242

MODELLING OF THE COAGULATION-ADSORPTION PROCESS IN TREATMENT SYSTEMS,
Wroclaw Technical Univ. (Poland). Inst. of Environment Protection Engineering.
A. M. Dziubek, and A. L. Kowal.
Water Science and Technology, Vol. 17, No. 6/7, p 1113-1120, 1985. 2 Fig, 5 Ref.

Descriptors: *Mathematical models, *Coagulation, *Adsorption, Water treatment, Wastewater treatment, Organic matter, Chemical treatment.

Removal of organics in water or wastewater treatment systems is often described mathematically in the form of Langmuir and Freundlich adsorption isotherms. Using these equations, it is convenient to model, e.g., the removal of organic matter in the adsorption process on an activated carbon bed. In chemical treatment processes, organic substances are frequently removed from the water or wastewater under treatment via an adsorption on the precipitation products. In this paper presented is a generalized model of the equation of a multilayer adsorption isotherm, which describes total organic carbon removal from a solution during chemical treatment in an alkaline medium. The model also includes the nonremovable concentration of organics. (Author's abstract)
W86-01245

HEXAVALENT CHROMIUM REMOVAL FROM DRINKING WATER,
Centre de Recherche de Maisons-Laffitte (France).
J. M. Philipot, F. Chaffange, and J. Sibony.
Water Science and Technology, Vol. 17, No. 6/7, p 1121-1132, 1985. 2 Fig, 3 Tab, 4 Ref.

Descriptors: *Chromium, *Drinking water, *Water treatment, Water pollution sources, Air pollution, Metal-finishing industry, Groundwater pollution, Iron sulfate, Filtration, Automation, Meulan district, France.

A series of tests were performed with a view to solving the problem of chromium pollution in the Meulan district near Paris (France) due to the proximity of long-established metal-working plants. It was found that the accumulated pollution not only originated from the groundwater source but also from atmospheric contamination through fall-out from smoke and fumes issuing from local metal-works' stacks. Among the interesting features of this paper is the fact that, since the profound penetration by the pollutant affects potable feedstock, chromium removal studies have been made on potable water for the first time on record. Several methods are reviewed, among which the only economically feasible one appears to be the reduction of hexavalent chromium by a sufficient quantity of iron sulfate, the problem attached to iron-sulfate overdose being solved by the application of high-rate filtration on very fine sand. This arrests the fine precipitates and reduces the residual ferrous-iron by catalysis. Reliability of the treatment is ensured by a system of continuous metering that automatically controls reagent dosing. (Author's abstract)
W86-01246

HYGIENIC EVALUATION OF BENTONITIC CLAYS AND FILTRATING MATERIAL FROM AZERBAIJHAN DEPOSITS. 2ND COMMUNICATION: TOXICOLOGIC AND HYGIENIC STUDIES OF THE BENTONITIC CLAYS FROM AGBURUN DEPOSITS (GIGIENICHESKAYA OTSENKA BENTONITOVYKH GLINI FILTRUYUSHCHEGO MATERIALA AZERBAIDZHANDSKOGO MESTOROZHDENIYA),
V. Iu. Akhundov, K. F. Akhundov, A. P. Mamedova, S. M. Dzhafaron, and N. N. Naumova.
Izvestiya Akademii Nauk Azerbaydzhanskoy SSR Seriya Biologicheskikh Nauk, No. 2, p 115-123, 1983. 1 Fig, 10 Tab.

Descriptors: *Bentonite, *Clays, *Filtering, *Agburun, *Azerbaijhan S.S.R., *Water treatment, *Baku, *Kura River, Sand, Soil types, Water chemistry, Hardness, Salinity, Turbidity, Toxicity.

Due to the high turbidity of the waters of the Kura River a special method of their treatment has been outlined in Baku. To intensify the purification process the application of bentonites from various deposits of Azerbaijhan along with coagulants and a special flocculating agent has been recommended, while substituting the quartzite sand with natural deposits as filtrating material. The suspensions of bentonites from Agburun coagulate in the presendece of Ca(2+), Mg(2+), Na(+), K(+) cations of natural waters. Coagulation occurs within a wide range of pH, water hardness, salinity, and turbidity. The use of bentonites decreases by 1.5 or 2 times the consumption of coagulating agents. When used in combination with flocculating agents the need for aluminum sulfate decreases to zero while increasing the yield of the water purification plants and maintaining a high quality water supply. The optimal doses of Agburun bentonites range between 10-200 mg/l. Application of aluminum sulfate or flocculating agents in addition to bentonite permits a decrease of the latter by 30-50%. To develop a toxicologic profile of these substances for the recommendation of their use in the purification of natural waters for water supply acute, subacute and chronic toxicity experiments were carried out on rats. The physiological parameters under investigation including a swim test, a erythrocyte and leukocyte count and the determination of blood catalase and peroxidase. The acute experiment indicated that bentonite was not toxic in that its maximum tolerable concentration for the experimental animals was of 66 g/kg. No alterations in blood composition were seen and the swim test was no different from the control animals. The subacute experiment lasting 2 months with bentonite administered orally in 1.5, 7.5, and 15.0 mg/kg doses revealed no alterations in the explored functions of the rats. The chronic experiment (6 Mo) with animals treated with similar dose of bentonite showed no changes in the above parameters. Bentonite from Agburun was then officially approved as a substance to be used in water purification for water supply. (Erdelyi-IVI)
W86-01257

AMSTERDAM WATER SUPPLY,
Amsterdam Water Supply (Netherlands).
C. van der Veen.
Journal of the American Water Works Association, Vol. 77, No. 6, p 32-45, June, 1983. 10 Fig, 2 Tab.

Descriptors: *Amsterdam, *Netherlands, *Water supply, *History, *Rhine River, Recharge, Water conveyance, Dunes, Aquifers, Water pollution sources.

The drinking water supply and treatment system in Amsterdam, dating from the mid-1850s takes advantage of the new and the old. Supplies are drawn from natural catchment areas in sand dunes, from the Rhine River, and from surface lakes as well as from groundwater. The dune-water source is recharged with pretreated surface water before it is treated to potable quality for distribution. Industrial water, which is not of drinking water quality, is delivered separately to steel mills, paper mills, and an oil refinery. The pollution of the Rhine River concerns water suppliers in cities, such as Amsterdam, that are located across international boundaries from the sources of pollution. The sources of water supply are overviewed, as are the treatment processes and the distribution system that serve the capital city of the Netherlands. (Author's abstract)
W86-01260

OLD AND THE NEW: BOGOTA'S WATER PLANTS,
G. A. Meier.
Journal of the American Water Works Association, Vol. 17, No. 6, p 66-69, June, 1985. 5 Fig.

Descriptors: *Water treatment facilities, *Drinking water, *Bogota, *Columbia, Developing countries, Filtration, Water supply development, Utilities.

Despite import restrictions and a raw water influent that can vary sharply because of the seasonal rains, Bogota (Colombia) continues to produce water of low turbidity and of excellent color and palatability. Bogota has been courageous and progressive with the construction of its new multimillion-dollar filtration plant, and the water utility is fastidious when it comes to producing good quality water. Since Bogota's temperatures are quite mild, distribution pipes need not be buried deeply. Most homes are equipped with a cylindrical rooftop tank, which is primarily used in emergency situations. The Vitelma treatment plant was built between 1933 and 1938, and although it is Bogota's oldest plant, it remains impressive in its meticulous maintenance and cathedral-like grandeur. The Francisco Wiesner plant (El Sapo) was built only two years ago. El Sapo is more technologically advanced than Vitelma and incorporates the up to date amenities of a computer monitoring system and a central control board. It also has a chemical lab furnished with the latest testing equipment. Metering seems to have reached all sections of Bogota. Many hydrants are old and faulty and will soon need repair. The existing hydrants are 20 or more blocks apart. (Baker-IVI)
W86-01262

DEVELOPING REGIONAL WATER SYSTEMS IN THE NETHERLANDS,
Texas Univ. at Austin.
D. J. Eaton.
Journal of the American Water Works Association, Vol. 77, No. 6, p 70-72, June, 1985. 6 Fig, 4 Ref.

Descriptors: *Netherlands, *Water supply development, *Planning, Water management, Drinking water, Water supply.

Over a 40 year period, beginning in the early 1920s, through a combination of self-help, sensible but affordable water rates, and partial government subsidies to promote extension of water services by regional utilities to remote areas, virtually all rural households in the Netherlands are now supplied with piped and treated drinking water. Although regional differences exist among rural water organizations, the water services of Noord Brabant, Zuid-West Nederland, Midden-Nederland, Noord-Holland, Overijssel, and Groningen are variations on the common theme. Each is a self-financing entity managed by a board selected by the local or provincial governments. Each developed from an impetus of local residents, assisted by a plan generated by the national RID (Government Office of Water Supply). Each provides water in rural areas and is able to take advantage of economies-of-scale for water extraction, treatment, and distribution. Each has used part of its income to finance continual extension of the distribution network into unserved rural areas. The pricing, personnel, and management policies have fostered loyalty and a sense of participation among users, employees, and local elected officials. The regional companies

have achieved more than their original aim of extending water supply to rural villages and farms. They have facilitated general infrastructure improvements. They have promoted the modernization of water related industries. Each company has been a steady employer of unskilled and semi-skilled labor in regions where unemployment levels have been relatively high. (Baker-IVI)
W86-01263

REDUCTION OF TURBIDITY BY A COAL-ALUMINUM FILTER,
Clarkson Coll. of Technology, Potsdam, NY. Dept. of Civil and Environmental Engineering.
A. G. Collins, and R. L. Johnson.
Journal of the American Water Works Association, Vol. 77, No. 6, p 88-92, June, 1985. 12 Fig, 4 Tab, 7 Ref.

Descriptors: *Water treatment, *Turbidity, *Coal-aluminum filters, Filtration, Filters, Drinking water, Hydrogen ion concentration, Aluminum.

Successful turbidity reduction using a coal-aluminum filter was achieved at a pH of 5.0 for both a synthetic and natural raw water with a filtration rate of 0.009 fps (10 m/hr). These conditions would probably generate approximately 200 micro-g/L of aluminum ions by corrosion of the media. Continuous operation of a coal-aluminum filter would require periodic replenishment of the aluminum particles. The laboratory data show that run durations could be expected to be between 10 and 20 hr at this influent pH. In general, the capital cost of a coal-aluminum filter plant will be significantly less than a conventional or direct filtration plant because coagulation, flocculation, and sedimentation units are unnecessary. In addition, there will be a significant reduction in the solids-handling process. The coal-aluminum filter process needs continuous monitoring of influent pH, possibly the addition of an acid to depress influent raw water pH to the desired level, replenishment of corroded aluminum, and the readjustment of the filter effluent to the desired pH level. The turbidity limit of 1.0 ntu could be met by a coal-aluminum filter. Influent raw water must be adjusted to the pH range of 4-6 to achieve this result. The exact pH conditions required for the production of an acceptable water quality vary with the raw water to be treated. (Baker-IVI)
W86-01266

OZONE INACTIVATION OF BOTULINUM TYPE E TOXIN,
National Marine Fisheries Service, Milford, CT. Milford Lab.
J. T. Graikoski, W. J. Blogoslawski, and J. Choromanski.
Ozone: Science and Engineering, Vol. 6, No. 4, p 229-234, 1984. 1 Fig, 1 Tab, 19 Ref.

Descriptors: *Ozonation, *Toxins, *Botulinum toxin, Water treatment, Drinking water, Ozone, Oxidation, Clostridium.

The effect of ozone gas on botulinum toxin type E has been examined. Under the conditions of this experiment, a twelve minute exposure to 8.5 ppm ozone, at a flow rate of 110 ml/minute, was adequate to inactivate completely 20000 MU/ml of toxin contained in a 65 ml volume. With 2000 MU/ml of toxin, less than one minute was needed to inactivate completely the toxin with an ozone concentration of 0.81 ppm. During the course of experimentation it was observed that the conditions existing during exposure of the toxin to the gas affected the rate of inactivation at a constant flow rate. These conditions included excess foaming and bubble size, which related to the contact time of the gas to toxin molecules. By controlling these variables, however, reproducible end points were achieved. (Baker-IVI)
W86-01267

PURIFICATION OF POLLUTED SOURCE WATER WITH OZONATION AND BIOLOGICAL ACTIVATED CARBON,
Harbin Civil Engineering Inst. (China). Water Pollution Control Lab.
B. Wang, J. Tian, and J. Yin.
Ozone: Science and Engineering, Vol. 6, No. 4, p 245-260, 1984. 17 Fig, 1 Tab, 17 Ref.

Descriptors: *Water treatment, *Ozonation, *Biological activated carbon, *Sand filtration, *Granular activated carbon, *China (Peoples Republic), *Harbin, *Heilongjiang, Activated carbon, Filtration, Turbidity, Color, Odor, Iron, Manganese, Organic substances, Chemical oxygen demand, Biological oxygen demand, Chromatograms, Ammonium, Nitrates, Water pollution.

In order to determine effective processes for purifying polluted source waters in Harbin City (Heilongjiang Province, China) various processes consisting of ozonation, sand filtration, and/or GAC filtration and adsorption, i.e., ozonation ('O3' Process), ozonation/sand filtration ('O3 + SF' Process), ozonation/biological activated carbon ('O3 + BAC' Process), ozonation/sand filtration/biological activated carbon ('O3 + SF + BAC' Proces), and granular activated carbon ('GAC' Process) were tested in an 8 cu m/d capacity pilot plant. In addition, a small plant of 500 L/d capacity was used to conduct comparative studies between the two processes 'GAC' and 'O3 + BAC', as well as two types of carbon. Of the processes tested, both the 'O3 + BAC' and 'O3 + SF + BAC' processes are most effective in removing various pollutants, including turbidity, color, odor, iron, manganese, organic substances measured as COD, BOC, chromatograms, and ammonium, nitrite, and nitrate ions. Specific efficiencies and mechanisms for removing such pollutants are described and discussed in detail. Based on the results of this study, two treatment flow sheets have been put forward for purifying polluted surface source water and polluted groundwater sources, respectively. (Author's abstract)
W86-01269

PRELIMINARY STUDY OF THE EFFICIENCY AND MECHANISM OF THM REMOVAL IN THE OZONATION AND BAC PROCESS,
Harbin Civil Engineering Inst. (China). Water Pollution Control Lab.
B. Wang, J. Yin, J. Tian, Q. Fan, and R. Liu.
Ozone: Science and Engineering, Vol. 6, No. 4, p 261-273, 1984. 8 Fig, 1 Tab, 16 Ref.

Descriptors: *Trihalomethanes, *Halogenated hydrocarbons, *Ozonation, *Water treatment, *Activated carbon, Chloroform, Water pollution sources, Chemical reactions, Anaerobic conditions, Adsorption.

A preliminary study on removing THMs from chlorinated water by ozonation ('O3' process) and granular activated carbon bed filtration and adsorption ('AC' process) was carried out. The chloroform content in chlorinated water was reduced to some extent by ozonation at low dosages, but then it increased steeply with time, and finally reached much higher than the original values. The GAC beds in both the 'AC' and 'O3 + AC' processes were found to be effective in removing chloroform by adsorption during their early operating period, corresponding to 4,000 - 5,000 bed volumes throughput, or one month duration for carbon X-11 and carbon ZJ-15 beds in the 'AC' process. With preozonation, i.e., the 'O3 + AC' process, the operating period with positive chloroform removal efficiencies was tripled. Nevertheless, the chloroform content in effluents from the GAC bed in both processes increased with operating time and throughput, and finally became much higher than the level in the influents. The phenomenon presumably was due to three mechanisms occurring in the carbon beds: 1) the biodegradation of complex chlorinated compounds into THMs: 2) the anaerobic digestion products can react with free chlorine in water to form THMs; 3) the desorption of THMs adsorbed on the carbon surfaces. In order to prevent the treated water from producing high concentrations of THMs, chlorination should be avoided before either the 'AC' or the 'O3 + AC' process. Home use carbon filters also are recommended to be used carefully and reasonably, for they can increase THM concentrations in effluents to levels much higher than those in the influents after a certain time of operation. (Author's abstract)
W86-01270

EFFECTS OF PH ON REMOVING LOW-LEVEL CHROMIUM CONTAMINATION IN GROUNDWATER,
Tennessee Technological Univ., Cookeville.
J. T. Mason, III, and C.-Y. P. Liau.
Journal of the Tennessee Academy of Science, Vol. 60, No. 3, p 77-79, July, 1985. 3 Fig, 2 Tab, 4 Ref.

Descriptors: *Chromium, *Hydrogen ion concentration, *Adsorption, Water treatment, Groundwater pollution, Adsorbents, Acidity, Flow rate.

Research on removal of low-level chromium contamination from samples of groundwater, along with included impurities, is described. A series of tests varying adsorbent amount, flow rate, and pH was conducted. In all cases the resin, Duolite ES-392, performed better than either of the carbons, Witco Witcarbon 950 or GECA Carborundum GAC 30, as adsorbents. The minimum adsorbent quantity (6 gm) and the medium flow rate (4.07635 ml/min) produced satisfactory chromium removal from pH 5 to 7 with the optimum pH somewhere closer to pH 5. The amount of chromium adsorbed increased from lower pH to near 5.6 and then decreased rapidly with increasing pH values in the groundwater. The effects of flow rate demonstrate that velocity is a significant factor in treating to under 0.05 mg/l chromium. (Baker-IVI)
W86-01316

5G. Water Quality Control

RESTORATION OF A SMALL LAKE BY COMBINED MECHANICAL AND BIOLOGICAL METHODS,
Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
V. Kucklentz.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2314-2317, 1985. 1 Fig, 2 Ref.

Descriptors: *Biological control, *Lake restoration, *Unterfoehringer See, *Germany (Federal Republic), Rehabilitation, Macrophytes, Fish, Ecological effects, Chara, Chlorophyta, Recreation, Phytoplankton, Carp, Microcystis, Cyanophyta, Cyclotella, Asterionella.

Removal of sludge, mechanical removal of macrophytes, and introduction of fish were tried in a series of attempts to improve clarity and prevent overgrowth of a small (5.5 hectare) swimming lake, the Unterfoehringer See, West Germany. In 1972, water quality was bad, and Secchi disk transparency had decreased by 0.8 m. In 1975/76, sludge was dredged from the lake, but in summer 1977, Chara hispida covered nearly the entire lake, making fishing and swimming impossible. In autumn 1977, the lake was drained and Chara mechanically removed. To prevent redevelopment of the Chara, 1,000 grass-carp (Ctenopharyngdon idealla Val.) were introduced to the lake in April 1978. Fish were observed feeding on the filamentous algae and on the young leaf buds of Chara but during summer mass development of phytoplankton occurred. In August and September 1979, massive Cyclotella and Asterionella appeared, and in October of that year the lake was drained again. Total grass carp biomass had increased from 190 kg to at least 622 kg since introduction. Grass-carp (totalling 75 kg) were restocked, and in May 1981 silver carp (150, mean weight 190 g) were introduced. In April 1983 two specimens of each species of fish were obtained; the grass carp weighed 2,200 and 2,650 g and the silver carp weighed 700 g and 950 g. Plankton blooms have continued, and since 1981 blue-green algae have increased significantly. Microcystis has appeared recently for the first time. (Rochester-IVI)
W86-00946

WATER QUALITY CONTROL IN IMPOUNDMENTS,
Institut Hygieny a Epidemiologie, Prague (Czechoslovakia).

J. Chalupa, L. Fiala, J. Popovsky, V. Sladecek, and P. Vasata.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 3-16, 1985. 3 Fig, 1 Tab, 39 Ref.

Descriptors: *Water quality control, *Reservoirs, Water pollution sources, Eutrophication, Multipurpose reservoirs, Sediments, Aquaculture, Network design, Sampling, Monitoring, Czechoslovakia.

This report on a seminar of the Water Research Institute in Prague deals with the methodological aspects of the measurement and evaluation of data for the water quality in impoundments in the CSSR mainly with respect to: the assessment of external causes, especially of anthropogenic influences in the catchment area, on the water quality (eutrophication, humic substances, trace elements), of the multi-purpose utilization of impoundments, the classification and development of the water quality in impoundments, the intensified utilization of impoundments as well as the influences of sediments and the effect of piscicultural measures on the water quality. The paper is subdivided into the following chapters: system of measurement network and analysis, stratification number of samples, number of the criteria to be investigated, extreme periods of discharge, multi-purpose utilization of impoundments, eutrophication, fish stocks. (Author's abstract)
W86-01006

GROUNDWATER POLLUTION HAZARD IN THE CAPE FLATS,
National Inst. for Water Research, Bellville (South Africa). Cape Regional Lab.
G. Tredoux.
Water Pollution Control, Vol. 83, No. 4, p 473-483, 1984. 11 Fig, 1 Tab, 10 Ref.

Descriptors: *Water quality control, *Monitoring, *Groundwater pollution, *Cape Flats, *South Africa, Water resources development, Groundwater, Water supply, Waste disposal.

The results of water quality monitoring in the Cape Flats are given and the implication of groundwater pollution are discussed, particularly in view of the proposed exploitation of the aquifer as a water source. The quality of the natural groundwater stored in the Cape Flats aquifer complies with the standards for domestic supplies, and the aquifer therefore has potential as a water supply source for Cape Town. The Cape Flats aquifer is unconfined, therefore it is vulnerable to pollution. In many places the groundwater level is close to the surface, which adds to the aquifer's susceptibility to pollution. Hazardous activities should be kept out of the area if the water source is to be protected. Pollution of the aquifer by leachates from landfills and sewage effluents has been proved by water quality monitoring. Waste disposal and sanitary landfilling should always be carried out with full precaution, even if pollution is not expected. The thickness of the unsaturated zone below a sanitary landfill is possibly the most important factor determining the groundwater pollution potential of the fill. Serious interaction takes place when the groundwater is in contact with the waste. The disposal of treated sewage effluent from an activated-sludge plant into the aquifer is not necessarily deleterious. Leachate from sludge drying beds should not be allowed to reach the aquifer. (Baker-IVI)
W86-01017

ESTIMATION OF THE LOADS OF SOME LIST I AND II SUBSTANCES TO UNITED KINGDOM TIDAL WATERS - A COMPARISON WITH PREVIOUS ESTIMATES,
Water Research Centre, Stevenage (England).
A. R. O'Donnell, and G. Mance.
Water Pollution Control, Vol. 83, No. 4, p 554-561, 1984. 1 Fig, 8 Tab, 7 Ref.

Descriptors: *Water quality control, *United Kingdom, *Pollution load, Wastewater discharge, Water pollution prevention, Rivers, Flow, Estimating, Coastal waters.

Current estimates of the loads of dangerous substances discharged to coastal waters in the United Kingdom are based on a comprehensive database including information from all significant land-based sources. The results are generally lower than previous estimates based on less comprehensive data. The loads discharged by rivers represent the largest percentage contribution to the overall inputs of these substances to coastal waters. Reduction of the uncertainty associated with quality data from sites reporting many results below the limit of detection, in combination with the utilization of flow data based on small sampling intervals, has resulted in a more realistic assessment of the loads contributed by rivers. For sewage discharges lacking quality data, estimated concentrations have been substituted. In general, the effluents, with measured water quality, serve large populations and the application of their quality data to other, smaller, discharges may bias these sewage load estimates. The loads from industrial discharges presented in this survey are undoubtedly overestimates, as a proportion of the loads have been evaluated using consented flows and concentrations. More realistic estimates of the loads of dangerous substances discharged to coastal waters can only be obtained from improved measurements of flow and water quality. (Baker-IVI)
W86-01025

STREAM DISSOLVED OXYGEN ANALYSIS AND CONTROL,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W86-01043

RISK ANALYSIS FOR SEISMIC DESIGN OF TAILINGS DAMS,
Consulting Geotechnial Engineer, Box 643, Indian Hills, Colo. 80454.
For primary bibliographic entry see Field 8D.
W86-01090

WATER QUALITY AND REGIONAL WATER SUPPLY PLANNING,
Corps of Engineers, San Francisco, CA. South Pacific Div.
For primary bibliographic entry see Field 4A.
W86-01101

RESTORATION OF LAKE VELUWE, THE NETHERLANDS, BY REDUCTION OF PHOSPHORUS LOADING AND FLUSHING,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
S. H. Hosper.
Water Science and Technology, Vol. 17, No. 4/5, p 757-768, 1985. 8 Fig, 5 Tab, 6 Ref.

Descriptors: *Lake restoration, *Phosphorus, *Lake Veluwe, *Netherlands, *Flushing, Eutrophication, Oscillatoria, Algae, Species diversity, Chlorophyll a, Biomass, Transparency.

In the shallow and hypertrophic Lake Veluwe (Netherlands) the cycling of phosphorus between water and sediments was mainly determined by a continuous bloom of the blue-green alga Oscillatoria agardhii. For the restoring of water quality it was considered necessary to reduce the external P-loading as well as to suppress the release of phosphorus from the sediments. The P-loading of the lake decreased from approximately 3 to 1 g P/sq m a year in 1979. Additionally the lake has been flushed during winter periods with water low in phosphorus. Flushing was primarily aimed at interrupting the continuous algal bloom. After four winters of intensified flushing Oscillatoria still is the dominant alga but the diversity of species is increasing. In 1982 Oscillatoria disappeared for several months. The results show a sharp decline of summer values of total phosphorus from 0.40-0.60 mg/l to approximately 0.15 mg/l. In the trend of various parameters correlated with algal biomass a striking discrepancy is observed. Chlorophyll-a, ashfree-dryweight and particulate-phosphorus show a considerable and approximately similar decrease (50-60%). On the other hand the decrease of algal biomass in terms of freshweight (viz. biovolume of Oscillatoria) and reciprocal Secchi-disc values is relatively small (approximately 25%). Obviously the O. agardhii filaments contain much less organic matter, chlorophyll-a, phosphorus and nitrogen per unit of biovolume after implementation of remedial measures. Transparency appears to be determined by number and volume of O. agardhii more than by chlorophyll-a and ashfree dryweight. Intensified flushing will be continued for the next few years. (Author's abstract)
W86-01198

WATER QUALITY CONTROL OF THE ANDELSE MAAS BASIN, THE NETHERLANDS, BY IRON DOSING,
Dune Water Works of The Hague (Netherlands).
A. C. Hoekstra, and K. D. Maiwald.
Water Science and Technology, Vol. 17, No. 4/5, p 769-780, 1985. 7 Fig, 3 Ref.

Descriptors: *Water quality control, *Andelse Maas Basin, *Netherlands, *Iron, Phosphates, Mathematical models, Nutrients, Algal growth, Eutrophication, Chlorophyll a, Orthophosphates.

The Dune Water Works of The Hague (Netherlands) pumps yearly about 45 million cu m of water from the Andelse Maas Basin to the dunes for infiltration purposes. The water in the Andelse Maas Basin in strongly influenced by the Meuse river. Phosphate concentrations are so high that algal growth causes difficulties in filters and dunes. For phosphate reduction purposes, iron is dosed into the basin. Several limnological variables are monitored based on weekly measurements. A mathematical model has been developed for the description of the eutrophication in the basin. The model is time and space dependent and based on one-dimensional dispersion-advection equation. Two separate submodels are used, one for the simulation of flow conditions and one for the algae nutrient kinetics. The ortho-phosphate reduction is modelled as a first order process. The eutrophication model has been calibrated, verified and used for a prediction of chlorophyll-a and ortho-phosphate concentrations for the case of the shut down of the iron dosing installation. The dosing of iron appears to be a very effective was for phosphate removal. Termination of the dosing would give unacceptable high phosphate and chlorophyll-a concentrations. Present investigations are focussed upon the minimization of the amount of iron dosing. (Author's abstract)
W86-01199

AQUATIC HABITAT ANALYSIS AS AN ELEMENT OF WATER RESOURCES PLANNING AND MANAGEMENT,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
E. E. Herricks.
Water Science and Technology, Vol. 17, No. 6/7, p 879-890, 1985. 6 Fig, 3 Tab, 16 Ref.

Descriptors: *Aquatic habitats, *Environmental quality, Water quality, Water resources development, Habitats, Aquatic environment, Habitat management, Instream flow, Illinois.

With increased emphasis on environmental quality objectives in water resources planning and management, past practices of simply considering water quality as the only environmental quality objective are inappropriate. Expanded environmental quality objectives include maintenance of high quality aquatic habitat. Water resource systems must provide both physical and chemical conditions appropriate for the propagation and maintenance of healthy diverse aquatic communities. Managing water resources to provide high quality habitat involves planning to meet both water quality and water quantity objectives. Existing technology based water quality controls and stream based water quality criteria can now be supplemented by aquatic habitat management. An approach to aquatic habitat management is illustrated by use of the Incremental Methodology developed by the U.S. Fish and Wildlife Service. The Incremental Methodology uses measures of aquatic habitat to assess instream flows required by aquatic life. Thus the range of environmental qual-

ity objectives in resources planning and management is expanded by application of these methods to include aquatic habitat as well as water quality management. Methods used to determine instream flow needs for rivers in Illinois are reviewed, and the use of this information in developing regulations limiting water extraction for off stream use are described. Aquatic habitat based management is shown to provide workable methods to meet expanded environmental quality objectives in water resources planning and management. (Author's abstract)
W86-01228

MODELING WATER QUALITY AND THE EFFECTS OF AGRICULTURAL BEST MANAGEMENT PRACTICES IN THE IOWA RIVER BASIN,
Anderson-Nichols and Co., Inc., Palo Alto, CA.
B. R. Bicknell, A. S. Donigian, Jr., and T. A. Barnwell.
Water Science and Technology, Vol. 17, No. 6/7, p 1141-1153, 1985. 6 Fig, 5 Tab, 7 Ref. EPA contract 68-03-2895.

Descriptors: *Model studies, *Water quality control, *Best management practices, *Agriculture, *Iowa River Basin, Hydrology, Nonpoint pollution sources, Path of pollutants, Simulation, Instream transport, Transformation, Sediments.

Comprehensive hydrology and water quality modeling were applied to the Iowa River Basin to evaluate the effects of agricultural nonpoint pollution and proposed best management practices (BMP). The model application combines detailed simulation of agricultural runoff and soil processes, including calculation of surface and subsurface pollutant transport to receiving water, with subsequent simulation of instream transport and transformation. The result is a comprehensive simulation of river basin water quality. This was part of a large study which included application and evaluation of the Hydrological Simulation Program - FORTRAN (HSPF) to both the data-intensive Four Mile Creek watershed and the Iowa River above Coralville Reservoir. The methodology developed on Four Mile Creek was extrapolated to the Iowa River Basin to demonstrate its applicability and functionality on a large river basin. Many model parameter values from Four Mile Creek were applied directly to the study area without adjustment while other parameters were modified based on available information and calibration. HSPF can be used to model the flow, sediment, and water quality (specifically pesticides and nitrogen nutrients) from large agricultural river basins. Extrapolation of parameter values from nearby or representative calibrated watersheds can be performed with a reasonable degree of confidence. With minimal calibration effort, simulation of flow frequencies on the main stem of the Iowa River was fair to good in this study, in spite of problems with deficient rainfall data and with modeling volume and timing of snowmelt runoff. Sediment simulation was poor due to insufficient calibration, lack of data, and model deficiencies. (Moore-IVI)
W86-01248

MARINE QUALITY STANDARDS: THEIR DERIVATION AND APPLICATION IN THE UNITED KINGDOM,
Water Research Centre, Stevenage (England).
G. Mance, and A. R. O'Donnell.
Water Science and Technology, Vol. 17, No. 6/7, p 1187-1198, 1985. 4 Fig, 2 Tab, 26 Ref.

Descriptors: *Standards, *Water quality, *Marine environment, *United Kingdom, Water pollution effects, Toxicity, Copper, Chromium, Lead, Nickel, Zinc, Arsenic, Coastal waters, Temperature effects, Salinity.

The Council of European Communities Directive on the discharge of Dangerous Substances requires Member States to eliminate pollution by List I substances and to reduce pollution by List II substances. For the List II substances, individual Member States are required to specify limit values by the environmental quality objective approach. The derivation of environmental quality standards (EQSs) for coastal waters and the difficulties of using such standards for controlling industrial discharges are discussed. Attention is focused on the common List II substances (copper, chromium, lead, nickel, zinc and arsenic) and their effects on marine life. Marine toxicity data are largely limited to relatively short exposure periods under conditions of constant temperature, salinity, and concentration of test substance. Insufficient attention has been directed to investigating the significance of such environmental factors as salinity and temperature on the toxicity of the List II heavy metals. Field studies of the environmental impact of heavy metal discharges to coastal waters are required that adequately describe the spatial and temporal variations in water quality as well as biota. In practice the available toxicity data enable an initial assessment of the EQSs. Progressive extension of regulatory controls to all tidal discharges, with the phased implementation of Part II of the Control of Pollution Act means that these tentative EQSs will be judged against the real world by their use in licensing existing discharges. Implementation of these controls will undoubtedly increase the availability of field impact assessments enabling the EQSs to be reviewed and subsequently restated with increased confidence. (Moore-IVI)
W86-01252

EEC SHELLFISH DIRECTIVE IN WALES,
University Coll. of Wales, Aberystwyth. Dept. of Botany and Microbiology.
S. N. Young, and P. Wathern.
Water Science and Technology, Vol. 17, No. 6/7, p 1199-1209, 1985. 1 Fig, 5 Tab, 13 Ref.

Descriptors: *Wales, *Shellfish, *Water quality standards, Water pollution control, International agreements, United Kingdon, Standards, Monitoring, Public health.

This paper contains details of the procedures adopted by the UK Government in implementing the EEC shellfish directive and a review of the water quality monitoring programs used by the Welsh Water Authority with respect to these provisions. Six shellfish beds have been surveyed in detail by the Authority, but only one has been designated. This is the only shellfishery which meets the standards. Raising the remainder to the required standards would involve considerable capital expenditure, mainly for sewage treatment. The UK Government has precluded such expenditure. It has claimed that any public health measures inherent in the directive are covered adequately by current UK practice. This stance is questioned in the light of a recent viral study. This paper highlights the potential problems when there is conflict between international and national water quality priorities. (Author's abstract)
W86-01253

OPERATION AND EFFICIENCY OF AUTOMATICALLY OPERATING WEIR STRUCTURES - A CONTRIBUTION TO CLEANER WATERS,
Technische Univ. Braunschweig (Germany, F.R.). Leichtweiss-Inst. fuer Wasserbau und Grundbau.
For primary bibliographic entry see Field 4A.
W86-01254

COUNTY RESTORES GROUNDWATER AQUIFER,
Fresno County Public Works Dept., CA.
R. D. Welton.
Public Works, Vol. 116, No. 7, p 58-60, July, 1985. 3 Fig.

Descriptors: *Aquifers, *Groundwater pollution, *Water quality control, Water supply, Landfills, Percolation, Leakage, Water pollution sources.

The Southeast Regional Solid Waste Commission's Disposal Site is a 74 acre municipal landfill that has recently acquired statewide notoriety in California because it is suspected of degrading groundwater in its immediate vicinity. This degradation primarily involves volatile organics trichloroethylene and tetrachlorethylene. The landfill operated between 1970 and 1979 without any detected water problems. In 1979 the groundwater monitoring detected an increase in iron and manganese in two of the monitoring wells. On investigation, the landfill was found to be saturated in several areas. Three possible sources of the moisture were discovered: an agricultural irrigation pipeline was leaking; a small segment of the landfill had been completed and landscaping had been installed with a drip type irrigation system which was leaking; and the interim level grade of the landfill did not properly redirect rainfall runoff and percolation was a problem. Two treatment options, a granular carbon filtration system and an air stripping process were considered for the removal of volatile organic and inorganic contamination. Field testing of the air stripping method showed it effectively removed volatile organics by volatilization and oxidized iron and manganese. This aquifer restoration project supports the contention that groundwater restoration is expensive, even with the low cost air spraying process used. Considering the low level of contamination and the small area involved in this project, the near half million dollar expenditure thus far equals about 40 cents for every ton of buried waste in the landfill. Future continued operational and maintenance costs are expected to cause the total cost to eclipse this half-million dollar amount. When confronted with a moving plume of contamination, it may be more efficient to attack the problem with a staged construction contract immediately. Quickly pursuing a project may reduce costs overall. (Baker-IVI)
W86-01314

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

ORGANIC POLLUTION; MANAGEMENT OF FRESH WATERS; INPUT OF SCIENTIFIC DATA INTO POLICY FORMULATION IN THE UNITED STATES,
College of New Rochelle, NY. School of Arts and Sciences.
M. M. Holland, and J. J. Balco.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2221-2225, 1985. 1 Fig, 2 Tab, 9 Ref.

Descriptors: *Resource management, *Policy making, *Environmental impact, *Water resources development, Resources development, Administrative agencies, Decision making, Administrative decisions.

Historically, there has been a strong federal role in the management of water resources in the United States. Prior to the 1970's water resource management decisions typically considered mainly economic factors; the agencies responsible for implementing programs (eg, US Army Corps of Engineers, Bureau of Reclamation, Soil Conservation Service, and Tennessee Valley Authority) have been, and continue to be, largely civil-engineering, construction-oriented agencies. Since passage of the National Environmental Policy Act in 1969 as well as other environment protection legislation, emphasis in mangement decisions has shifted from economic benefits toward considerations of impacts of human activities on ecosystems. The institutional arrangements for water resource management decision-making in the United States are exceedingly complex, and scientific input is not necessarily the basis of policies. Two recent examples of scientific participation in the decision-making process governing management of US freshwater wetlands are: (1) the wetlands preservation program of The Nature Conservancy, a private group that acquires critically important wetland areas to ensure their preservation, and (2) a program sponsored by the US Department of Transportation Federal Highway Administration, in which scientists were asked to review a report on functional wetland assessment. A third way for scientists to have input in the decision-making process is through increasing public awareness, because Congressmen vote as their constituents tell them. In the future, three steps are necessary to increase the influence of scientists in the decision-making proc-

ess governing US fresh waters: (1) create standard methodologies for obtaining, presenting, and evaluating data; (2) develop policies that recognize that ecosystems are dynamic resources; and (3) improve communication between scientists and important groups of nonscientist, such as economists, the news media, personnel of regulatory agencies, and, especially, the average citizen. (Rochester-IVI)
W86-00933

MULTI-OBJECTIVE DECISION-MAKING IN WASTE DISPOSAL PLANNING,
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 5E.
W86-01044

COMPUTERIZATION CAN BOOST UTILITY PERFORMANCE,
Cincinnati Univ., OH. Dept. of Mechanical and Industrial Engineering.
For primary bibliographic entry see Field 5F.
W86-01084

PROBLEMS IN WATER RESOURCES UTILIZATION,
Asian Inst. of Tech., Bangkok (Thailand).
I. Fude.
Indian Journal of Power and River Valley Development, Vol. 33, No. 5/6, p 175-180 and 187, May-June, 1983.

Descriptors: *Water resources development, *Planning, Conservation, Economic aspects, Soil erosion, Water demand, Water quality, Hydroelectric plants, Technology transfer, Flood control, Agriculture.

In this era of scientific proliferation, startling new discoveries and inventions are being made in an unceasing stream, but the application of modern scientific discoveries and principles in water technology lags far behind. Areas in which attention is needed include: conservation of water supply; excesses in water resources planning; screening and review of water development plans; post-implementation cost accounting; financing water resource development; the need for reservoir storage space; soil erosion; energy and power surveys; underground hydroelectric powerplants; manpower planning; research and development; dissemination and exchange of information; standardization of measurement systems; the accumulation of useful experience; daily weather reports, flood control, agricultural production; and water quality. In water resources utilization, solutions can be found through the imagination, ingenuity and industry of the people and the transfer of technology and expertise. Care must be taken in the transplant of technique and methodology without adaptation or modification to suit or meet peculiar local or national requirements. (Moore-IVI)
W86-01206

MECHANISATION VS. MANUAL EXECUTION OF RIVER VALLEY PROJECTS IN MAHARASHTRA,
Bhatsa Project Circle, Thane (India).
V. R. Deuskar, and M. V. Bhave.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 330-342, September-October, 1983. 4 Fig, 5 Tab.

Descriptors: *Construction, *Mechanization, *Maharashtra, *India, Planning, Dams, Canals, Water resources development, Dams, Hydroelectric plants, Irrigation projects, Water supply.

The subject of mechanization vs. manual labor in river valley construction projects has been discussed in Maharashtra for the last two or three decades. The river valley projects may be irrigation, water supply, hydropower, or multipurpose plans. There appears to be no single answer to the the problem of choosing mechanization or manual labor, which would be applicable to all situations and all times. Each case is an individual by itself and a choice has to be made by those in charge after taking into account many factors such as site conditions, time available, machinery and equipment already in hand, the need regarding providing employment, possibility of repetitive use of machinery, ready availability of labor and others. In the long run the trend is toward mechanization, and India will also be caught up in this trend. In the near future the construction industry will have to gear up for gigantic projects, and mechanization for the critical elements of these will be inescapable in order to keep on construction schedules. (Baker-IVI)
W86-01215

TOMORROW'S TECHNOLOGY FOR TODAY'S PROBLEMS,
Wessex Water Authority, Bristol (England).
For primary bibliographic entry see Field 8A.
W86-01261

6B. Evaluation Process

INCREASE OF THE EFFECTIVENESS OF USING THE HYDROPOWER RESOURCES OF THE ENISEI RIVER,
G. S. Arsev'ev.
Hydrotechnical Construction, Vol. 18, No. 10, p 461-464, October, 1984. 1 Tab, 4 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 4-6, October, 1984.

Descriptors: *Enisei River, *USSR, *Hydroelectric power, Water resources development, Economic evaluation, Efficiency, Runoff, Electrical networks, Water management, Interbasin transfers.

For hydropower stations with a different degree of regulation and located on rivers with an asynchronous runoff regime, when united into an integrated power grid, the most effective operating regime is a regime of compensating electric power regulation, as a result of which the effectiveness of using the hydropower resources and total firm output increase. The effect of asynchronous runoff and the effect of compensating regulation on the total firm output of hydrostations under combined operating conditions of existing and planned hydrostations in the lower Enisei basin (USSR) were investigated. Investigations were carried out by direct comparison of the variation of the runoff from different parts of the basin and determination of the correlations for a combined period of observations from the 1937-1938 to the 1975-1976 water management years. Calculations to establish the effect of asynchronism of the annual runoff on an increase of the total firm output of hydrostations both in the case of independent and compensating regulation were performed on the basis of using the equation of the variance of the total series composed as a result of adding individual n series. The results indicate that the onetime economic effect due to organizing and conducting interbasin compensating regulation at hydrostations in the lower Enisei basin can amount (at a cost of 176 rubles per 1 kW of installed capacity of a thermal power station and with consideration of construction of transmission lines) to about 160 million rubles. (Baker-IVI)
W86-00986

INVENTORYING GROUND WATER IN CRYSTALLINE ROCKS OF PIEDMONT REGION,
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 2F.
W86-01104

WATER RESOURCES ENGINEERING EDUCATION,
Virginia Water Resources Research Center, Blacksburg.
W. R. Walker, and P. G. Bridgeman.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 338-345, July, 1985. 12 Ref.

Descriptors: *Education, *Water resources engineering, Engineering, Social aspects, Political aspects, Economic aspects, Planning, Management.

Water resources engineering education may hinder the development of practioners who must be not only technically proficient, but also capable of managing engineering problems in a social, political, and economic context. Professional water resources engineering requires the ability to communicate in interdisciplinary efforts, to plan public information programs, and to factor legal and social input, as well as technical know-how, into problem solving. Opportunities to improve water resources engineering education include: (1) New methods of evaluating students that include assessments of communications skills; (2) broadened course requirements linking technical and social science/humanities programs through joint appointments, faculty exchanges, or social science/humanities courses tailor-made for the engineering student; (3) a shift from traditional graduate training to providing an opportunity for graduate research on open-ended problems typically found in water resources engineering; (4) nonoptional co-op experience in the real world; and (5) evaluation outside of the accreditation process to encourage program experimentation. Professional practitioners can only benefit by such educational improvements and should provide substantial external support for basic research evaluating engineering education curricula, as well as support for and involvement in curriculum development. (Author's abstract)
W86-01107

INVESTIGATION OF DAM SITES: MODERN PRACTICES,
National Hydroelectric Power Corp. Ltd., New Delhi (India).
For primary bibliographic entry see Field 8E.
W86-01210

LOW HEAD CANAL POWER DEVELOPMENT IN PUNJAB,
Thapar Coll. of Engineering, Patiala (India).
P. V. Gupta, and M. S. Dua.
Indian Journal of Power and River Valley Development, Vol. 33, No. 12, p 411-424, December, 1983. 3 Tab, 13 Ref.

Descriptors: *Canals, *Hydroelectric plants, *Low head, *Punjab, *India, Construction, Planning, Water resources development, Costs.

A state such as Punjab (India) should take advantage of the operating experiences with small hydroelectric generating units gained in other countries. The necessary technical knowhow and manufacturing capability apparently exists in Punjab and such developments will be helpful in saving the exhaustible sources of energy such as coal and oil. A great deal of water flowing through existing canals could be put to work at relatively low cost to generate electricity. The cost of generating units from these small hydroelectric schemes will be a little more than generating costs from major projects but is is definitely very much less than thermal diesel generation costs. The main argument in favor of small hydroelectric schemes is that these can start functioning in a period of 1.5 years to 2 years with resources within budgetary limits of the State. (Baker-IVI)
W86-01221

HYDROPOWER SCENARIO,
Uttar Pradesh Irrigation Dept., Lucknow (India).
P. S. Nigam.
Indian Journal of Power and River Valley Development, Vol. 33, No. 12, p 421-424, December, 1983. 3 Ref.

Descriptors: *Water resources development, *Hydroelectric plants, *Uttar Pradesh, *India, *Planning, Dam construction, Tunnels, Economic aspects, Multipurpose reservoirs, Irrigation canals.

The advantage of hydro power is that the source is renewable and the production of power does not consume the water. The main objection against the large hydro schemes has been the high initial investment involved in the beginning and the long gestation required before the benefits could be reaped. In India during 1981-82 the total energy

generation was about 123 TWh of which the share of hydro was 40.3%, thermal 56.6%, nuclear 2.4%, and diesel and gas turbine 0.7%. In Uttar Pradesh by the end of 1968 percentage of hydro installation was about 52% of the total capacity. The pace of hydroelectric development slowed down after 1960 in spite of its intrinsic merits. The most important factor was a lack of financial resources. The total hydro potential in Uttar Pradesh is estimated to be 13,000 MW of which only 1,200 MW have been commissioned so far. Having used only 9% of the hydro potential in the State it is necessary to accelerate hydro power development by establishing an organization entirely devoted to hydro power and multipurpose projects and having separate allocations for hydro power. It is necessary to employ cheaper and expeditious methods of construction for dams and tunnels even if it may involve importing technology. Large multipurpose and hydroelectric projects should be so planned that interim partial benefits are derived in an economical manner. Mini hydro schemes on existing irrigation canals can fill up the gaps in long development period projects. Research and development programs for unconventional renewable sources of electricity should be accelerated. (Baker-IVI)
W86-01222

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

STATE WATER SUPPLY MANAGEMENT IN NEW JERSEY,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
W. Whipple, Jr.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 284-292, July, 1985. 1 Fig, 1 Tab.

Descriptors: *Water supply development, *Water conveyance, *New Jersey, Drought, Water pollution, Groundwater pollution, Management, Planning, Regulations, Feasibility, Loans.

In New Jersey, existing water supply problems involve water availability during droughts and other emergencies, contamination, especially of ground water, and institutional problems. A drought occurred in 1980, just as the new Water Supply Master Plan was completed; and a large bond issue was approved, together with statutes greatly strengthening the State's authority for water supply management. As a consequence, the State has a very advanced water supplying planning, regulatory and management program, which includes both positive and negative incentives to follow State guidance. To date, the State has built and manages only three water supply projects, and the Federal government, none. Thus, the greater part of new development and of system rehabilitation, is carried out by the 620 public water supply systems of the State (many of which are privately owned). New Jersey policy emphasizes management and problem-solving. Feasibility planning, backed up by regulatory requirements to provide an adequate standard of service, encourages local initiative. Low interest loans, rather than grants, are used to encourage high priority programs such as remedial work in contaminated well fields. (Author's abstract)
W86-01103

6E. Water Law and Institutions

REGIONALIZATION: A DECADE POINTS TO MORE CHANGE,
Water Authorities Association, London (England).
L. Hill.
Water Engineering and Management, Vol. 132, No. 6, p 40-45, June, 1985.

Descriptors: *Water management, *England, *Wales, *Wastewater treatment, *Water treatment, *Regionalization, Water conveyance, Management, Training, Organizations, Sludge disposal, Public policy.

In 1974 the responsibilities of over 1500 organizations for water supply, wastewater collection and treatment, and rivers were assumed by just ten autonomous water authorities in England and Wales. Additional changes are now being made, aimed at streamlining the water industry through changes made in the structure of the water authorities themselves. Training within the industry is now the job of the Water Industry Training Association, a company operating on commercial lines. A new central body was also established. Recent reductions in capital expenditures in real terms has brought about a greater emphasis on project appraisal. The water industry's first priority is to ensure that supplies are not a source of infection from harmful organisms. This involves the protection of sources, the disinfection of water supplies, and the monitoring of water in distribution systems. Britain's Water Research Center is now paying more attention to sludge disposal as well as sludge treatment in response to advice from water authorities. In considering future policy for sludge dumping in the seas around England and Wales, the water industry is most concerned in understanding the contribution made by sewage sludge to total polluting loads. The choice of sludge disposal routes is essentially a question of balancing risk avoidance against cost reduction. (Baker-IVI)
W86-01086

DETERMINATION OF URBAN FLOOD DAMAGES,
Corps of Engineers, Baltimore, MD. Baltimore District.
S. J. Appelbaum.
Journal of Water Resources Planning and Management, Vol. 111, No. 3, p 269-283, July, 1985. 8 Tab, 13 Ref.

Descriptors: *Flood damage, *Urban areas, *Computers, Utilities, Transportation, Emergency services, Housing, Commercial establishments, Costs.

A new methodology and computer program, DAPROG 2, have been developed by the Baltimore District, Corps of Engineers to estimate urban flood damages. Stage-damage relationships are computered for individual residential and commercial properties. These individual relationships are the aggregated into composite stage-damage relationships for an entire reach. For residential properties, replacement values for the structure and contents are estimated and applied to depth-percent damage relationships in order to develop stage-damage relationships. Regression equations have been developed to estimate structure replacement cost from physical attributes which are easily obtained in the field. Contents values are also estimated from the data obtained in the field. For commercial properties, standard stage-damage relationships for 67 types of businesses are used. Utility and transportation damages and emergency care costs are also computed. The computer program is interactive and allows the user to correct data errors online. The program has several optional features and reports which are selected by the user. DAPROG 2 has been successfully used by the Baltimore District in several flood control studies. DAPROG 2 has also been used by other Corps Districts and state agencies. (Author's abstract)
W86-01102

EEC SHELLFISH DIRECTIVE IN WALES,
University Coll. of Wales, Aberystwyth. Dept. of Botany and Microbiology.
For primary bibliographic entry see Field 5G.
W86-01253

6G. Ecologic Impact Of Water Development

ABOUT A SOURCE OF NUTRIENTS IN THE TROPICAL RIVER RAJANG (N BORNEO) IN RELATION TO FUTURE IMPOUNDMENT,
Forschungsinstitut und Natur-Museum Senckenberg, Frankfurt am Main (Germany, F.R.).
A. Lelek.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2115-2118, 1985. 1 Fig, 9 Ref.

Descriptors: *Nutrients, *River Rajang, *Borneo, *Environmental effects, *Reservoirs, Water level, Water resources development, Resources development, Tropical regions.

Nutrients and organic matter in the large load of drifting vegetative debris in the Rajang River (North Borneo) could have serious negative consequences for the water quality within an impoundment if one were constructed in the upper reaches of this river. A distinctive characteristic of the Rajang River is its large, rapid changes in water level; daily changes of 3-5 m are the rule. This feature, combined with pulses of debris washed into streams by tropical storm runoff, creates a shifting load of vegetative debris, some of which contributes to the nutrition of fish and invertebrates in the river. The debris tends to be removed from the upper reaches of the river and moved downstream, where it accumulates particularly at the confluences with tributary streams. If an impoundment were constructed, this debris would wash into the impoundment, with potentially disastrous consequences for water quality (anaerobiosis, hydrogen sulfide release), particularly if existing vegetation is not removed from the affected area prior to flooding. It is recommended that vegetation be cleared from the zone to be flooded and that leaf traps be set up on tributary streams to trap forest litter so that it can become partly mineralized before carried into the man-made lake. (Rochester-IVI)
W86-00921

ORGANIC POLLUTION; MANAGEMENT OF FRESH WATERS: INPUT OF SCIENTIFIC DATA INTO POLICY FORMULATION IN THE UNITED STATES,
College of New Rochelle, NY. School of Arts and Sciences.
For primary bibliographic entry see Field 6A.
W86-00933

ENERGY EXTRACTION FROM LAKE SEDIMENTS WITH HEAT EXCHANGERS. EFFECTS ON WATER QUALITY, SEDIMENT, BOTTOM FAUNA, AND FISH,
Lund Univ. (Sweden). Limnological Inst.
L. Leonardson.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2249-2253, 1985. 4 Fig, 13 Ref.

Descriptors: *Energy sources, *Resource development, *Environmental effects, *Water quality, *Lake sediments, *Benthos, *Fish, Heat transfer, Water temperature, Sediments, Midges.

Studies conducted over the winter-spring 1982/83 period showed that a closed pipe heat exchanger system caused no negative or positive changes in water quality, sediment-water interactions, or bottom fauna in a Swedish lake. It is possible that the lack of observed environmental effects resulted from the relative mildness of the winter of 1982/83 (only 1 mo of ice cover). Water temperature near the pipe was as low as 2 C, but sediment oxygen levels, sediment chironomid levels, and rates of chironomid emergence did not differ between the sediments containing the pipe field and the undisturbed area. In this study, 3,300 m of pipe of 40 mm outside diameter was laid out on the sediments of an experimental lake of 18,000 sq m surface area in southern Sweden. Two closed pipe systems were used, one sunk down in the lake sediments and one dug down in an adjacent field. Brine temperature during winter within the sediments was expected to be less than -5 C. This heat exchange system resembles the more than 600 closed-system heat exchangers for energy extraction from lake water or sediment that have been installed in Sweden from 1978-82. (Rochester-IVI)
W86-00938

EFFECTS OF IMPOUNDMENT AND DRAWDOWN ON THE FISH COMMUNITY OF A SOUTH AMERICAN RIVER,
British Columbia Univ., Vancouver. Inst. of

Animal Resource Ecology.
T. G. Northcote, M. S. Arcifa, and O. Froehlich.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2704-2711, March, 1985. 2 Fig, 3 Tab, 16 Ref.

Descriptors: *Americana Reservoir, *Atibaia River, *Brazil, *Fish populations, *Eutrophication, *Dam effects, Reservoir operation, Water resources development, Environmental effects, Population dynamics, Food chains.

The Americana Reservoir (Brazil) was formed by a 25 m high dam constructed on the Atibaia River, some 500 km above its confluence with the middle Parana. Limnological characteristics of the eutrophic and polymictic reservoir are well documented as are general effects of pollution from sewage and industrial outfalls. The Atibaia River prior to impoundment had a moderately rich fish community probably composed of some 90 species, mostly characoids and siluroids. Of the 65 species apparently no longer present 30 years after impoundment, over two-thirds were siluroids whereas a lower reduction occurred in the characoids, leaving a post-impoundment fish community dominated by this latter group. Not all the changes in the fish community following impoundment of the Atibaia River can be related to changes associated with the shift from lotic to lentic conditions. During this same period there also has been marked eutrophication of the system as well as severe pollution by heavy metals, phenols, herbicides and other materials. The recent and sudden drawdown of Americana Reservoir apparently did not produce major changes in relative abundance of many fish species. The reduction in conditions for the planktivorous Astyanax following drawdown may be a food chain effect related to the concomitant decline in phytoplankton and zooplankton abundance. (Baker-IVI)
W86-00978

HUMIC ACIDS IN THE INFLOWS TO THE FLAJE RESERVOIR AFTER DEFORESTATION OF ITS WATERSHED,
Vyzkumny Ustav Vodohspodarsky, Prague (Czechoslovakia).
J. Micka, L. Fiala, and J. Chalupa.
Acta Hydrochimica et Hydrobiologica, Vol. 13, No. 1, p 47-52, 1985. 3 Fig, 2 Tab, 3 Ref.

Descriptors: *Humic acids, *Deforestation, *Watersheds, *Flaje Reservoir, *Czechoslovakia, Air pollution, Peat bogs, Forest watersheds, Chemical oxygen demand, Color, Nitrates, Vegetation.

Flaje Reservoir (Czechoslovakia) was first filled in 1960. Water quality in the reservoir after filling was compared with that for the period 1976-1982. When the reservoir was first filled, 70% of the watershed was still covered by forests; at present only about 35% of the area is covered by forests and the large peat bogs are practically bare of trees. This deforestation was caused by air pollution from a nearby industrial region. The concentration of humic matter decreased from the original 8 mg/l to 4 mg/l. The relationships between the COD-Mn and humic acid concentration, and color can be described by a linear function. Parallel to deforestation, the nitrate concentration increased; this can be explained by the higher nitrogen concentration in precipitation. The improvement in color, COD, and humic acid concentrations after deforestation may be due to coherent plant growth that developed on the deforested surface of peat bogs and prevented the original erosion and eluation of the forest soil. (Moore-IVI)
W86-01010

RESERVOIR IMPACTS: A SYNTHESIS OF A 10-YEAR RESEARCH PROJECT,
Ohio Agricultural Research and Development Center, Wooster. Dept. of Agricultural Economics.
T. L. Napier, W. R. Goe, and M. V. Carter.
Water Resources Research, Vol. 21, No. 6, p 801-807, June, 1985. 34 Ref.

Descriptors: *Reservoirs, *Social aspects, Environmental effects, Water resources development, Ohio.

The purpose of this paper is to present a synthesis of research findings derived from longitudinal monitoring of a reservoir affected community group located in the urban fringe of a major metropolitan community in central Ohio. Data were collected at three time periods to assess the social impacts of rapid change on local people. Data were collected over a 10-year period using standardized measurement devices to ensure comparability of the information collected. The research findings demonstrate that extensive modification of social and physical environments did not result in the destruction of the social fabric of the affected group. Observations over time suggest that the affected group has accommodated many of the changes introduced in the community and has accepted the lake project. (Author's abstract)
W86-01071

SIMULATING FISH REDISTRIBUTION IN THE LG-2 RESERVOIR AFTER FLOODING,
Sherbrooke Univ. (Quebec). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 8I.
W86-01166

GROWTH RATE OF YEARLING COLORADO SQUAWFISH AT DIFFERENT WATER TEMPERATURES,
National Fisheries Center-Leetown, Kearneysville, WV.
T. Black, and R. V. Bulkey.
Southwestern Naturalist, Vol. 30, No. 2, p 253-257, May, 1985. 2 Tab, 15 Ref.

Descriptors: *Water temperature, *Ecological effects, *Water resources development, *Squawfish, *Growth, Fish physiology, River basin development, Resources development, Animal physiology, Fish populations.

One of the major habitat changes imposed on the upper Colorado River drainage by dam construction was an altered annual water temperature pattern which results in much lower summer water temperatures in significant portions of the drainage. Specimens of the endangered Colorado squawfish, Ptychocheilus lucius, which have been caught in recent years have been half as long as specimens caught in the past; the change in annual river temperature has been cited as the possible cause of an apparent reduction in growth rate of the species. Research was conducted to determine the optimum growth temperature for Colorado squawfish and the relation between optimum growth temperature and final thermal preferendum for this species. Growth rate of yearling Colorado squawfish over a 12-week period was determined for fish held at 15, 20, 25, and 30 C with excess food. The effect of temperature on growth rate was highly significant; fastest growth occurred at 25 C. Fish gained about 0.3 gram at 15 C, 0.9 gram at 20 and 30 C. and 1.7 grams at 25 C during the 12-week period. Results suggest that 25 C, the final thermal preferendum, is the temperature at which Colorado squawfish grow fastest with abundant feed. Reduced water temperature below dams in the Colorado River drainage could well have lowered growth rate of Colorado squawfish from historic levels. Future water shortage and development projects should be designed to provide summer water temperatures as near the optimum growth level as feasible. (Collier-IVI)
W86-01169

AQUATIC HABITAT ANALYSIS AS AN ELEMENT OF WATER RESOURCES PLANNING AND MANAGEMENT,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W86-01228

SURFACE WATER QUALITY IN RELATION TO SOIL TYPE, LAND USE AND DISCHARGE IN A RURAL CATCHMENT AREA,
Utrecht Rijksuniversiteit (Netherlands). Environmental Research Group.
For primary bibliographic entry see Field 5B.
W86-01249

ANALYSIS OF THE BENTHIC MACROINVERTEBRATE COMMUNITY OF A FLUCTUATING RIVER-RESERVOIR ZONE IN MIDDLE TENNESSEE,
Florida State Dept. of Environmental Regulation, West Palm Beach.
S. K. Burian.
Journal of the Tennessee Academy of Science, Vol. 60, No. 3, p 79-84, July, 1985. 4 Fig, 2 Tab, 25 Ref.

Descriptors: *Benthic environment, *Invertebrates, *Tennessee, *Rivers, *Reservoirs, Spatial distribution, Temporal distribution, Population dynamics, Dam effects, Environmental effects.

The effects of controlled retention on the structure of the benthic macroinvertebrate community of the Falling Water River within the headwaters zone of influence of Center Hill Reservoir in Middle Tennessee were investigated. Changes in benthic community structure in relation to changes in river channel morphology were studied using cluster analysis. Associated matrices and dendrograms were constructed using the Pinkham and Pearson coefficient of association. Distinctly different benthic communities were identified through cluster analysis and appeared to result from the alteration of micro- and macrohabitats as fluctuations in river-reservoir stage occurred. In addition, cluster analysis with the Pinkham and Pearson coefficient proved to be an effective means of providing information on the relative environmental tolerances of the 94 taxa of benthic invertebrates identified during this study. (Baker-IVI)
W86-01317

7. RESOURCES DATA

7A. Network Design

VARIANCE REDUCTION ANALYSIS,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2F.
W86-01075

CONTINUOUS CONVOLUTION WITH HYDROLOGIC DATA,
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
For primary bibliographic entry see Field 2A.
W86-01076

7B. Data Acquisition

COMPARISON OF PLANKTONIC AND PERIPHYTIC MICROALGAL PARAMETERS AS INDICATORS OF EUTROPHICATION IN A BALTIC ARCHIPELAGO: ANNUAL SUCCESSION OF COMMUNITY PARAMETERS,
Tvarminne Zoological Station (Finland).
T. Tamminen, and E. Leskinen.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2195-2202, 1985. 5 Fig, 2 Tab, 8 Ref.

Descriptors: *Phytoplankton, *Periphyton, *Eutrophication, *Bioindicators, *Archipelagos, *Baltic Sea, *Finland, *Succession, Indicators, Nutrients, Primary productivity, Phosphorus, Monitoring.

The value of periphyton studies in practical monitoring was illustrated by a study in which planktonic and periphytic primary productivity, chlorophyll a, particulate organic carbon, and nitrogen were compared as indicators of eutrophication due to ammonium pollution in a brackish water archipelago in the Baltic Sea on the southern coast of Finland. Periphyton was sampled on 10 x 10 cm tile-red ceramic panels, which were exposed on the bottom (depth 2 m) at an angle of 45 degrees, facing southwest. Exposures lasted 5 wk, except during winter when substrates were exposed for

4.5 mo. Nutrient ratios (inorganic N/P and nutrient balance ratio) indicated a phosphorus deficiency in some spring and early summer samples, whereas nitrogen appeared to be the main limiting nutrient for algal growth at other periods. Of the measured phytoplankton parameters, only the primary productivity/particulate organic carbon (P/B) ratio differed consistently between the polluted and control areas. Periphytic microalgal colonization was 10 times greater in the polluted area during early summer. The average turnover time of the community (B/P) was an order of magnitude higher in periphyton than in the plankton. The periphyton community is more cumulative and less dynamic than the plankton community, yet it shows succession within time frames that are reasonable for sensitive monitoring of the aquatic environment. (Rochester-IVI)
W86-00931

EVALUATION OF THE USE OF ARTIFICIAL SUBSTRATES IN SAMPLING THE INVERTEBRATE FAUNA OF SEWAGE FUNGUS SLIMES IN IRISH RIVERS,
Trinity Coll., Dublin (Ireland). Dept. of Zoology.
J. D. Reynolds, and C. Hunter.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2239-2243, 1985. 3 Fig, 1 Tab, 6 Ref.

Descriptors: *Biological samples, *Benthos, *Artificial substrates, *Sewage fungus slimes, *Ireland, Fungus, Water pollution effects, Bioindicators, Indicators.

Knitted nylon pan scourers, approx 9 cm in diameter by 3 cm thick, collected stream invertebrates in a way that was broadly comparable to standardized kick samples at upstream sites and sewage fungus collections at downstream sites, thus permitting comparison between these two different methods. Samples were collected, and artificial substrates were exposed, during August and September in two tributaries of the River Shannon, Ireland. The scourers placed upstream yielded similar numbers of organisms and taxa to those in 2-min kick samples, but biomass of substrates was low. Diversity tended to be lower in the substrates at upstream samples. Although some differences between pan-scourers and sewage fungus samples were observed at downstream sites (where domestic sewage, food, or milk waste pollution was present), the downstream scourers appeared to simulate vegetation overgrown by sewage fungus fairly closely according to faunal results. Kick samples tended to collect more worms, leeches, and molluscs than did sewage fungus samples, when compared with scourer results in each case. The pan-scourers were most attractive to crevice-entering organisms such as Asellus, Gammarus, and Ostracoda, whereas those requiring a firm substrate (eg, Similium larvae) were less favored. Pan-scourers are cheap, standard, and easily used in different experimental configurations, and they appear suited to the difficult conditions of variable flow and actively eroding stream beds encountered in many Irish streams. (Rochester-IVI)
W86-00936

USE OF BACTERIA ATTACHED TO SUBMERGED MACROPHYTES AND GLASS SLIDES AS INDICATORS OF AN INCREASING WATER POLLUTION,
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Bodenkunde und Standortslehre.
H.-J. Lorch, and J. C. G. Ottow.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2297-2302, 1985. 4 Fig, 1 Tab, 8 Ref.

Descriptors: *Bacteria, *Epiphyton, *Bioindicators, *Water pollution effects, *River Erms, *Germany (Federal Republic), Indicators, Macrophytes, Aquatic plants, Species composition, Nutrients.

The natural community of bacteria epiphytic on submerged Berula erecta and Ranunculus trichophyllus and periphytic on exposed glass slides was examined at an oligotrophic and a eutrophic site on the River Erms (West Germany), a chalk stream. Light microscopy and scanning electron microscopy were employed. Periphyton of the differently polluted zones showed characteristic 'Aufwuchs', depending on the time of exposure. Slides from the oligotrophic site revealed mainly cocci within 3 days, whereas those exposed in the eutrophic zone showed densely scattered rods and sheathed forms directly after exposure. The longer the exposure period, the more similar were the periphytic microfloras of the two sites, both in terms of size and forms. The bacteria on B. erecta and R. trichophyllus appeared to be concentrated in the grooves of the leaves. This epiphyton at the unpolluted site consisted mainly of rod-shaped cells and threads that showed remarkable similarity to the periphytic 'Aufwuchs' observed at the eutrophic site. Bacteria from the oligotrophic site may be considered as 'Kuemmerformen' (starved forms); they appear to develop into rods if exposed to higher nutrient supplies for a longer period. Nutrients derived from plants (or leaf exudates) may account for the smaller differences observed between epiphytic floras from polluted and unpolluted sites than between the glass slide microfloras from these sites. (Rochester-IVI)
W86-00943

MULTILEVEL APPROACH TO THE ASSESSMENT OF ECOTOXICOLOGICAL EFFECTS IN A HEAVY METAL POLLUTED STREAM,
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W86-00953

USE OF AQUATIC BRYOPHYTES TO MONITOR HEAVY METALS POLLUTION OF FRESHWATERS AS ILLUSTRATED BY CASE STUDIES,
Metz Univ. (France). Lab. d'Ecologie.
C. Mouvet.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 4, p 2420-2425, 1985. 3 Fig, 3 Tab, 8 Ref.

Descriptors: *Bioindicators, *Bryophytes, *Heavy metals, *France, *Cance River, *Fensch River, *Bienne River, Metals, Water pollution effects, Bioaccumulation, Indicators, Arsenic, Cadmium, Copper, Iron, Lead, Zinc.

Applications of aquatic bryophytes as monitors of heavy metal contamination are illustrated by three case studies; a tannery, iron and steel plants, and metal coating factories. Along the Cance River (a tributary of the Rhone River, France), where tannery effluents were present, Platyhypnidium exhibited slightly higher contents of metals (As, Cd, Cu, Fe, Pb, Zn) than Fontinalis at most stations, but the downstream profiles were similar. Along the Fensch River (a tributary of the Moselle River, France), where steel rolling mills and blast furnaces are responsible for heavy metal inputs, new records were set for concentrations of metals in aquatic bryophytes (P. riparioides): 277 g Zn/Kg, 98 g Fe/kg, 15 g Cr/kg, 3.7 g Cu/kg, 2.9 g Pb/kg, and 187 mg As/kg. The record values of Fe, Cr, and As were obtained on bryophytes transplanted for just three days in the most polluted site. At the third site, the Bienne River (a tributary of the Ain River, France), where many small metal coating factories contribute pollution, it was possible to pinpoint individual sources of Cu among 13 metal coating factories located as little as 300 m apart. Aquatic bryophytes offer numerous advantages in pollution monitoring compared to other organisms such as phytoplankton, periphyton, macrophytes, and macroscopic algae. Bryophytes (Cinclidotus, Fontinalis, Platyhypnidium, Scapania, and others) are easily sampled and identified, have high concentration factors, are attached and perennial, tolerate high levels of toxicants, and show a highly significant correlation between their contents of heavy metals and concentrations in the water. (Rochester-IVI)
W86-00962

PHOTOSYNTHETIC ACTIVITY OF DOMINANT ALGAL SPECIES IN EUTROPHIC SHALLOW LAKE (GROSSER MUGGELSEE, BERLIN) INVESTIGATED BY MICROAUTORADIOGRAPHY,
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographie und Geooekologie.
For primary bibliographic entry see Field 2H.
W86-01131

SUITABILITY OF DIFFERENT COUNTING VIALS AND LIQUID SCINTILLATORS FOR DETERMINING TRITIUM IN WATER (DIE EIGNUNG VERSCHIEDENER MESSFLASCHCHEN UND SZINTILLATORFLUSSIGKEITEN ZUR BESTIMMUNG VON TRITIUM IN WASSER),
Bundesanstalt fuer Gewaesserkunde, Coblenz (Germany, F.R.).
W. J. Krause.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 18, No. 3, p 141-160, June, 1985. 16 Fig, 6 Tab, 1 Ref.

Descriptors: *Measuring instruments, *Tritium, *Liquid scintillators, Water analysis, Calibrations, Sensitivity, Radioisotopes.

Twentyone glass and plastic counting vials and 15 liquid scintillators commercially offered for determining tritium in water have been examined with regard to their suitability. For this purpose a comparison of their characteristics has been made, including counting efficiency, quality quotient, figure of merit, calibration factor and sensibility of measurement arrangement and also the mean background for samples in several 20 ml counting vials at optimum mixing ratio of scintillator cocktail to water. From this comparison a qualitative assessment has been derived and on this basis suitable counting vials and liquid scintillator cocktails for determining high and low tritium contents (low level range) have been recommended. (Author's abstract)
W86-01142

LEACHATE ATTENUATION IN THE UNSATURATED ZONE BENEATH LANDFILLS: INSTRUMENTATION AND MONITORING OF A SITE IN SOUTHERN ENGLAND,
Aspinwall and Co., Shrewsbury (England).
For primary bibliographic entry see Field 5A.
W86-01177

ANALYSIS OF ORGANICALLY COMPLEXED ELEMENT CONTENTS IN SEDIMENTS AND SLUDGES (ZUR ANALYTIK ORGANISCH-KOMPLEXIERTER ELEMENTGEHALTE IN SEDIMENTEN UND SCHLAMMEN),
Goettingen Univ. (Germany, F.R.). Inst. fuer Anorganische Chemie.
W. Schlosser, and G. Schwedt.
Fresenius's Zeitschrift fur Analytische Chemie, Vol. 321, No. 2, p 136-140, May, 1985. 2 Fig, 6 Tab, 9 Ref.

Descriptors: *Complexation, *Metals, *Chemical analysis, *Sediments, *Sludge, *Extraction, Lead, Copper, Zinc, Organic solvents, Sequential extraction, Sodium acetate, Ammonium acetate, Fate of pollutants.

The extractability from a purification sludge of organically bound Pb, Cu and Zn with various organic solvents is studied systematically. A significant part in the range of 10% of the whole content was found for Cu only. Liquid-liquid distribution of the ammonium and sodium acetate extracts from the standard sequential extraction procedure by organic solvents in combination with photometric direct determinations of the labile contents show that the metals Fe, Cu and Zn are complexed to different extents. The results of this differentiating analysis for some sludges and sediments are demonstrated. (Author's abstract)
W86-01301

LABORATORY INVESTIGATION AND ANALYSIS OF A GROUND-WATER FLOWMETER,
Auburn Univ., AL. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W86-01310

7C. Evaluation, Processing and Publication

ANALYTICAL REPRESENTATION OF THE VAN EVERDINGEN-HURST AQUIFER INFLUENCE FUNCTIONS FOR RESERVOIR SIMULATION,
Keplinger and Associates, Inc., Tulsa, OK.
For primary bibliographic entry see Field 2F.
W86-01139

8. ENGINEERING WORKS

8A. Structures

RECONSTRUCTION OF A DAM WATER INTAKE UNDER CONDITIONS OF CONTINUOUS OPERATION OF THE RESERVOIR,
S. S. Golik.
Hydrotechnical Construction, Vol. 18, No. 10, p 484-489, October, 1984. 5 Fig, 1 Tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 20-23, October, 1984.

Descriptors: *Intakes, *Dam construction, *Reconstruction, Earth dams, Tunnels, Embankments.

In 1983, construction was completed on building up the barrier of a reservoir in the Crimea, consisting of a class II earth dam, retaining embankment, and concrete overflow dam. Simultaneously, the dam water intake was reconstructed. The reservoir was operated continuously as a water supply during the reconstruction period. The dam intake consists of a tunnel located under the dam, head and tail walls. Considerable deformation occurred in the intake tunnel after the first phase of filling the reservoir. The intake reconstruction involved reinforcement of the tunnel and dry chamber of the head wall, and the provision of intake at the increased useful storage level after the reconstruction of the reservoir. A continuous operation regime of the intake and deliver of water to consumers during repair of the structures was maintained. (Keenan-IVI)
W86-00990

MODEL FOR BEAM-MODE BUCKLING OF BURIED PIPELINES,
Texas Univ. at Austin. Dept. of Aerospace Engineering and Engineering Mechanics.
H. Yun, and S. Kyriakides.
Journal of Engineering Mechanics, Vol. 111, No. 2, p 235-253, February, 1985. 17 Fig, 1 Tab, 16 Ref. NSF grant CEE-8140043.

Descriptors: *Pipelines, *Beam mode buckling, *Compression, Seismic properties, Pipes, Mathematical models, Deformation, Buckling, Mechanical failure, Design criteria.

Large ground movements (such as fault movements, landslides, and sediment subsidence) can cause a line to develop compressive loads which can lead to buckling. Lines on the ground surface or buried in relatively shallow trenches tend to behave essentially as beams. Under compression, a section of the line lifts through the ground. An attempt is made to modeling the so-called 'beam mode buckling' exhibited under compression in pipelines. The line is modeled as a long heavy beam on a contacting surface. The reacting surface is modeled first as an elastic and subsequently as a rigid foundation, with the additional constraint that it only reacts to compressive loads. The problem is assumed to possess a localized imperfection. Under compressive axial load, a section of the beam lifts off the foundation. The problem is studied through a large deflection extensional beam nonlinear formulation. The large deflection response of the beam is found to exhibit a limit load which is shown to be imperfection sensitive. Numerical examples using actual pipe parameters clearly indicated that the limit load is reached with relatively small vertical and axial displacements of the beam. Provided the pipe continues to behave as a beam (i.e., the limit load is less than the shell-buckling load of the pipe), the pipe can sustain deformations well beyond the limit load without failure. Pipelines can be designed to ensure that in the event of excessive compression, they buckle out of the ground but remain operational and structurally sound. This can be achieved by designing periodically placed imperfections in the pipeline. (Moore-IVI)
W86-01079

SIMPLIFIED EARTHQUAKE ANALYSIS OF CONCRETE GRAVITY DAMS: SEPARATE HYDRODYNAMIC AND FOUNDATION INTERACTION EFFECTS,
Texas Univ. at Austin. Dept. of Civil Engineering.
G. Fenves, and A. K. Chopra.
Journal of Engineering Mechanics, Vol. 111, No. 6, p 715-735, June, 1985. 12 Fig, 20 Ref, 1 Append. NSF grants CEE-8120308 and CEE-84011439.

Descriptors: *Earthquakes, *Gravity dams, *Hydrodynamics, *Dam foundation, Concrete dams, Vibration, Reservoirs, Mathematical equations.

Simplified procedures are presented for the analysis of the fundamental vibration mode response of concrete gravity dam systems for two special cases: (a) Dams with reservoirs of impounded water supported on rigid foundation rock; and (b) dams with empty reservoirs supported on flexible foundation rock. In the first case, the effects of dam-water interaction and reservoir bottom absorption on dam response are included, whereas the effects of dam-foundation rock interaction are included in the second case. In each case, the response of the fundamental vibration mode of a dam monolith is modeled by an equivalent single degree-of-freedom system with frequency-independent properties chosen to represent the effects of complicated, frequency-dependent hydrodynamic terms or foundation-rock flexibility terms, as appropriate. The maximum earthquake-induced deformations and equivalent lateral forces can be computed using the response spectrum for a special ground motion. The procedures and results presented in this paper are extended in a companion paper to develop a simplified analytical procedure for concrete gravity dams that includes the simultaneous effects of dam-water interaction, reservoir bottom absorption, and dam-foundation rock interaction. (Author's abstract)
W86-01080

SIMPLIFIED EARTHQUAKE ANALYSIS OF CONCRETE GRAVITY DAMS: COMBINED HYDRODYNAMIC AND FOUNDATION INTERACTION EFFECTS,
Texas Univ. at Austin. Dept. of Civil Engineering.
G. Fenves, and A. K. Chopra.
Journal of Engineering Mechanics, Vol. 111, No. 6, p 736-756, June, 1985. 8 Fig, 10 Ref, 2 Append. NSF grants CEE-8120308 and CEE-8401439.

Descriptors: *Earthquakes, *Gravity dams, *Hydrodynamics, *Dam foundations, Concrete dams, Rock mechanics, Dam-water interactions, Reservoirs, Mathematical equations.

A companion paper presented simplified procedures for earthquake analysis of the fundamental mode response of concrete gravity dams including the separate effects of dam-foundation rock interaction and dam-water interaction with reservoir bottom absorption. These procedures are extended to develop a simplified analytical procedure for evaluation of the response of concrete gravity dams to earthquake ground motion including the simultaneous effects of dam-water interaction, reservoir bottom absorption, and dam-foundation rock interaction. Expressions for the parameters of an equivalent SDF (single degree-of-freedom) system that models the fundamental mode response of dams are derived, a procedure to implement the analytical procedure is outlined, and an extension to consider the response contributions of the higher vibration modes of the dam is briefly mentioned. (Author's abstract)
W86-01081

HYDRAULIC DESIGN OF FREE OVER-FALL SPILLWAY,
Masan Dam Investigation Div., Bagaha (India).
C. Singh.
Indian Journal of Power and River Valley Development, Vol. 33, No. 7/8, p 204-212, July-August, 1983. 17 Fig, 11 Ref.

Descriptors: *Free over-fall spillways, *Spillways, Hydraulic design, Arch dams, Buttress dams, Gravity dams, Control crest, Terminal structures, Hydraulic head, Aeration.

In the free over-fall spillway, the discharge after flowing over the control crest falls into the downstream, because there is no structure below supporting crest up to the point of impingement to support that falling jet. The free over-fall spillway is always an integral part of a dam of arch, buttress or gravity type with the downstream face vertical or of reverse slope. It has only two components, the control crest on the top and the terminal structure at the toe of the dam, with adequate provision of aeration below the lower nappe of the free falling flow. This type of spillway is limited to particular types of dams, and it involves simplicity of design and overall economy in project cost, operation and maintenance. Discharge increases with increase in operating head and the operating head has no barrier, so it is hydraulically efficient. The terminal structure provided at the toe of the dam protects it and adjoining works from the eroding and undermining action of the spillway discharge. This type of spillway has provided trouble-free service at the 230 ft high Calder Wood Arch Dam built in Tennessee in 1930 and the 215 ft high Couesque Arch Dam (France) built in 1950. This type of spillway has enough scope for adoption in case the spillway is to be based on a circular well foundation. (Moore-IVI)
W86-01208

ROLE OF CONSTRUCTION MANAGEMENT, METHODS AND EQUIPMENT IN CONSTRUCTION OF HYDROELECTRIC PROJECTS IN INDIA,
National Hydroelectric Power Corp. Ltd., New Delhi (India).
O. P. Sharma.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 249-256, September-October, 1983.

Descriptors: *Hydroelectric plants, *India, *Construction, Management, Mechanization, Management information systems, Planning, Maintenance, Economic aspects, Safety.

Speed, economy, quality and safety being prime considerations in hydro-power project constructions having unique problems, modern construction management and technology, advanced methods and techniques, greater mechanization and import of consultancy and expertise are the only answers. Network planning techniques, management information system, sound organization, teamwork in congenial construction atmosphere, need based and result oriented approach are essential ingredients. Scientific and systematic construction planning, programming, phasing and synchronizing sequence of construction using appropriate methods and techniques lead to accelerated progress. Equipment planning by experts, timely procurement and commissioning of construction plant, their optimum use avoiding idling of heavy equipment, regular maintenance for high efficiency and adequate supply of spares and accessories, ensure speed and economy. Safety considerations both during training and operation of dedicated operators/workers would ensure speed and dependability in high mechanization. (Author's abstract)
W86-01209

FARAKKA - THE LARGEST BARRAGE IN THE WORLD - AN ENGINEERING MARVEL,
Gujarat Narmada Water Dispute (India).
D. Mookerjea.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 282-289, September-October, 1983. 6 Ref.

Descriptors: *Farakka Barrage, *Ganga River, *India, *Bangladesh, *West Bengal, Construction,

Floods, Water resources development, Barrages, Monsoons, Flow discharge.

The Farakka Barrage built across the Ganga is located near the border of West Bengal, India and Bangladesh. The Ganga is a perennial river with an average water level in the non-monsoon season running at about EL 55.00 (16.8 m) and corresponding discharge of about 3.976 cu m/sec. In the monsoon season, July to September, the water level generally rises to about EL 80.00 (24.40 m). The Farakka Barrage was constructed right inside the deep channel of the river with a movable bed of fine sand and minimum depth of water in the dry season of about 20 ft, 6 m. Problems of construction and the sequence of construction of coffer dam are discussed. A type of coffer dam evolved during the construction accounted for a substantial cost reduction. Even before the Farakka Complex was commissioned, the rail and road bridges had been opened to traffic. With an ad hoc agreement between India and Bangladesh regarding sharing of Ganga waters, pending final arrangement the Farakka Complex had started operation from the end of April 1975 with a discharge of 16,000 cusecs. The effect of this reduced discharge was studied by a joint team of experts. The discharge through Farakka Canal was maintained at 40,000 cusecs even after the monsoon of 1975. This flow had provided remarkable improvement in the navigable reaches and the usual change of deeper channel during ebb tide in the earlier years was absent. (Baker-IVI)
W86-01211

CASE HISTORY OF 1000 MW DEHAR POWER PLANT - BEAS SUTLEJ LINK PROJECT,
Beas Dam, Talwara.
O. P. Datta, and S. L. Aggarwal.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 290-307, September-October, 1983. 11 Fig, 1 Tab, 11 Ref.

Descriptors: *Hydroelectric plants, *Construction, Design criteria, Management, Turbines, Generators, Economic aspects, Construction materials, Construction equipment, Administration.

The 1000 MW capacity Dehar Power Plant is located in Himachal Pradesh, India. The water for driving the turbines is obtained by diverting the waters of the river Deas through the Pandoh Baggi Tunnel. The construction work on this limb of the project commenced in 1972 and the first of the six generating units each of 165 MW installed capacity was commissioned in November, 1977. The topics discussed include: choice of speed of turbines and type of generators; control of silt entry into power plant; seismic design; method adopted to place second stage concrete around scroll case; and the provision of combined cooling water and draft tube unwatering pumps and observation of unequal distribution of discharge from two openings of the draft tube. Design and construction aspects for expeditious and economic construction of future hydro-power plants are considered, including the benefits of providing two EOT cranes, each of half of the total capacity required; provision of precast crane girders and roof members; mechanization of production and placement of concrete; introduction of 1 ft sheets and reinforcement bar lists for job facility; and fabrication of complete reinforcement cages for beams and columns in the workshop and their erections at the site. The administration, while working within the framework of rules, should be practical, considerate, decisive and ready to remove avoidable constraints of the rules when required in the interest of work. The construction schedules should be based on detailed investigations. Better renumeration and cash incentives should be provided for the project staff working in remote and hazardous areas and along the critical line. (Moore-IVI)
W86-01212

MECHANIZED TUNNELLING - A LANDMARK IN INDIAN TUNNELLING PRACTICE,
National Hydroelectric Power Corp. Ltd., New Delhi (India).
V. Ram, and S. K. Roy.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 349-353, 364, September-October, 1983. 3 Fig, 7 Ref.

Descriptors: *Construction, *Tunnel construction, *India, *Manipur, Tunnels, Water resources development, Planning, Mechanization, Hydroelectric plants, Geology, Penstocks.

The role of mechanized tunnelling in India is considered along with conditions under which it may be deployed and the experienced gained during the process in the maiden Indian hydroelectric project. India saw its first mechanized tunnelling operation in Loktak Hydroelectric Project in the State of Manipur. The 100 million dollar Loktak Hydroelectric Project situated in the Manipur State anticipates diversion of 58.8 cumecs of water from the Loktak Lake with a view to utilize 42 cumecs for generation of power with a gross head of 312 meters and supply of 16.8 cumecs for lift irrigation. The water will be diverted from the lake through a water conductor system comprising 2.27 km of open channel, 1.073 km of cut and cover section and 6.65 km long, 3.81 m finished diameter of horsehoe shaped head race tunnel terminating in the penstock manifold at the surge tank end. The three penstocks laid on the surface slope of the hill have an average length of 1346 meters each. The power plant situated at the bank of Leimatak river houses 3 units of 35 MW each. The tunnel traverses through lake sediments in the initial reaches followed by terrace deposits in about 1250 km length and splintery shales with subordinate sandstone and silt stone bands of Disangs and Barail Series in the remaining reach. A number of predominant faults have affected these rock formations with steep dip either towards east or west. The use of the Alpine Miner AM-50 is described, which is a selective cutting machine designed for operation in medium hard rock up to an unconfined compressive strength of about 1000 kg/sq cm. The machine can economically excavate a wide range of rocks encountered in underground mining and tunnelling. (Baker-IVI)
W86-01216

TUNNEL EXCAVATION WITH ALPINE MINER AM-50 (A CASE HISTORY AT LOKTAK H.E. PROJECT, MANIPUR),
Loktak Hydroelectric Project (India). Management Services Div.
D. P. Verma, and M. M. Madan.
Indian Journal of Power and River Valley Developments, Vol. 33, No. 9/10, p 354-364, September-October, 1983. 2 Fig.

Descriptors: *Tunneling, *Construction equipment, *Excavation, Loktak Hydroelectric Project, Manipur, India, Hazardous conditions, Methane, Hydroelectric plants.

The work of tunnelling at the Loktak Hydroelectric Project, Manipur, India was suspended due to a methane gas explosion during excavation in 1975. In 1977, construction on two faces was resumed using two roadheader Alpine miners AM-50 (imported from Austria) A detailed study was made on the working of the machine, consumption of spare parts under different geological conditions, and the various practical problems. If the machine breaks down, it may not be possible to move it out until it is repaired. No arc welding or gas cutting is allowed inside the tunnel because it contains highly inflammable methane gas, which resulted in unanticipated delays. The machine is most suitable only where supporting system is of secondary importance and continuous excavation is possible so as to get maximum utilization of the machine. In tunnels where rock strength ranges from 150 to 400 kg/sq cm, after excavation the rock has to be supported immediately and the maximum time is taken for providing permanent supports. In soft ground conditions where seepage water is present, bogging down of the miner consumes most of the time and the operation must be carried out very carefully. (Moore-IVI)
W86-01217

THREE DIMENSIONAL FINITE ELEMENT STRESS ANALYSIS OF GRAVITY DAMS,
Indian Inst. of Tech., New Delhi.
D. K. Sehgal, R. Natarajan, and S. M. A. Kazimi.
Indian Journal of Power and River Valley Development, Vol. 33, No. 11, p 394-396, November, 1983. 4 Fig, 7 Ref.

Descriptors: *Gravity dams, *Finite element method, *Stress analysis, Computers, Model studies, Dams, Stress, Strain, Concrete dams.

Three dimensional finite element analysis of a concrete gravity dam block is done and results are compared with those obtained by a two dimensional finite element analysis. The geometry of a 100 m high concrete gravity dam was chosen for this study. The dam is divided into 49 elements with 246 nodes. Twenty noded, isoparametric, rectangular prism elements are used and displacements are allowed to vary in parabolic fashion. There are differences between the stresses predicted by 2D and 3D analysis. The major point of difference is the area of the tension zone. A 2D analysis shows a smaller tension zone surrounding the heel of the dam and upstream face of the foundation, whereas 3D analysis gives a much bigger tension zone. For the preliminary design of a dam, to save computer time and man time, one can go ahead with 2D analysis. However, for the exact analysis for final design, 3D analysis is recommended. This becomes almost essential for the cases where either the foundation is nonhomogeneous or the geometry of the dam changes along the longitudinal axis. This type of study keeps a stress analyst aware of the magnitude of inaccuracies involved in simple plane strain analysis for such problems. (Baker-IVI)
W86-01219

TOMORROW'S TECHNOLOGY FOR TODAY'S PROBLEMS,
Wessex Water Authority, Bristol (England).
K. F. Roberts.
Journal of the American Water Works Association, Vol. 77, No. 6, p 59-65, June, 1985. 5 Fig, 8 Ref.

Descriptors: *Water supply systems, *England, *Wales, *Wessex, *Management planning, *Administrative agencies, Water distribution, Water districts, Water mains, Maintenance costs, Sewer systems.

Since standards in Britain vary so greatly, even within a single network, and programs of asset replacement have only in more recent years been tackled in a planned and systematic way, the traditional problems of water distribution (peak demand, pressure variations, burst mains, unaccounted-for water) have increased in seriousness rather than having been overcome. The problems associated with aging underground distribution networks in the United Kingdom are being addressed at the national and regional levels. Some 80,000 burst pipes, excluding mains, are repaired each year, and the cost of these repairs is at least $75 million annually; most of the bursts occur in lines of 6 in. diameter or less, which represents 80% of the nation's distribution system. The 1974 reorganization of management of the entire water cycle in England and Wales created 10 regional water authorities whose boundaries were decided on the basis of natural water basin catchments rather than on artificial political or commercial criteria. The Wessex Water Authority's use of telemetry to reduce stresses on distribution networks and extend the life of underground assets is described. The potential effectiveness of renovation as an alternative to replacement was demonstrated by calculations that show that if renovation could be applied to two thirds of the system at, say, a third of the cost of replacement, then the total cost of overall replacement would be cut by nearly half. A major change in the financial regulations under which water authorities operate was introduced in Great Britain in 1982 with a move from historical- to current-cost accounting. (Collier-IVI)
W86-01261

ENERGY STORAGE: DEVELOPMENTS IN PUMPED-STORAGE,
Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Machines Hydrauliques.

For primary bibliographic entry see Field 8C.
W86-01272

DESIGN AND OPERATION OF A FUSE-PLUG SPILLWAY IN SWAZILAND,
Watermeyer, Legge, Piesold and Uhlmann, London (England).
E. T. Engels, and A. Sheerman-Chase.
International Water Power and Dam Construction, Vol. 37, No. 6, p 26-28, June, 1985. 4 Fig, 1 Tab, 4 Ref.

Descriptors: *Design criteria, *Spillways, *Fuse-plug spillways, *Swaziland, *Umbuluzi River, Water resources development, Dam construction, Costs, Floods.

The combination of a concrete-lined spillway and an emergency spillway with a two-level erodible bund control provided an economical accomodation of flood discharges resulting from Cyclone Domoina, which deposited more than 400 mm of rain on the catchment above the Umbuluzi River dam at Mnjoli, Swaziland. Within less than half an hour, the double-bund fuse plug washed out, and the spillway opened. Topsoil and vegetation in the valley below the spillway were washed away in a strip about 120 m wide, and the flood eroded a channel some 40-60 m side and up to 10 m deep. The dam was not damaged, nor was their unacceptable loss of freeboard as a result of this flood event. The emergency spillway operation was entirely controlled by the water level, with no human intervention. The spillways at Mnjoli cost $1,118,800 (1977 prices), of which 63% was for the concrete spillway and 37% for the emergency spillway with the erodible fuse-plug bunds. The cost of reinstatement of the erodible bunds in the emergency spillway is estimated to be $40,800 (1984 rates), and to replace a waterline and gravel road below the spillway that were washed away will require an additional $9,100. (Rochester-IVI)
W86-01275

POWER CONDUITS FOR HIGH-HEAD PLANTS,
Innsbruck Univ. (Austria). Inst. fuer Konstruktiven Wasserbau und Tunnelbau.
G. Seeber.
International Water Power and Dam Construction, Vol. 37, No. 6, p 50-54, June, 1985. 10 Fig, 12 Ref.

Descriptors: *High-head storage plants, *Pumped storage, *Pressure tunnels, *Tunnels, Tunnel lining, Stress, Design criteria, Pipelines, Concrete, Unlined tunnels, Construction joints, Construction materials.

Loading of pressure tunnels and shafts, and lining techniques are reviewed, with particular reference to the problems existing in plants of large size (600-700 MW), heads of up to 1,000-1,500 m, and dam heights up to 300 m. Increases in hydrostatic load have not been the main source of problems in these new plants, rather, it has been the increase the dynamic, or pulsating load, that has caused problems in conduits. Introduction of automatic control equipment has meant more abrupt changes in operating conditions. Incorporation of a reverse-flow control throttle (Thoma throttle) in the surge chamber has helped reduce large oscillation in this area. Operation in the pumping mode involves higher frequency, but smaller amplitude pressure waves which quickly lead to alternating stress numbers greater than 10 to the 10th power. Imposing operating restrictions or incorporating damping elements are ways to reduce dynamic load in peak-load stations. Rock pressure cannot be counted on as a counteracting external force to equalize pressure on the inner lining of conduits. Only groundwater pressure can be incorporated into lining calculations as a pressure relief, particularly where it is higher than the turbine water pressure. Lining techniques suitable for high-pressure power conduits include no lining in suitable rock and concrete linings, of which the latter are particularly common in the Alps. In unlined tunnels there is no groundwater support pressure, requiring that more emphasis be placed on adequate primary pressure, that is, overburden thickness. Cooling and shrinkage deformations of concrete tunnel linings can lead to contractions approximately double the proof strength of the concrete, leading to cracks or gaps. Grouting can be employed to add the mechanical strength of the rock mass to that of the concrete, thus enabling much higher pressures to be absorbed. Almost double the internal pressure can absorbed with such a design under average site conditions, but such concrete linings have the disadvantage that they are subjected to high levels of continuous tensile stress during operation. (Rochester-IVI)
W86-01277

8B. Hydraulics

DAMMING THE VOLGA CHANNEL AT THE CHEBOKSARY HYDROELECTRIC STATION,
B. M. Erakhtin.
Hydrotechnical Construction, Vol. 18, No. 10, p 465-472, October, 1984. 4 Fig, 7 Tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 6-12, October, 1984.

Descriptors: *Dam construction, *Hydroelectric plants, *Volga Channel, *Cheboksary hydroelectric station, *USSR, Evaluation, Planning, Construction, Hydraulicking, Berms, Scour.

The Cheboksary hydroelectric station is the fifth and final step of the Volga transport-power cascade. The frontal, pioneer, and bermless methods were examined as possible damming methods. It proved to be technically possible to use the pioneer method for damming large rivers such as this, with erodible channels with depths of 18 m, discharges to 3000-3500 cu m/sec, and a drop of about 60 cm. The economic expediency of such damming should be determined in relation to the cost of stone at the construction site. Damming of large rivers with the use of hydraulicking is possible during intense ice formation. In the case of an erodible channel it is necessary to dump the berm from both banks simultaneously to prevent deep scouring of the bottom. To reduce consumption of stone materials, it is expedient to carry out hydraulic filling of the underwater part of the dam simultaneously with dumping the berm without lagging behind it. In the case of pioneer damming of rivers with an erodible channel, reliable protection of the bottom of the gap is necessary. Protection by a train of stone and rubble with a thickness of 1 m is no guarantee against scouring. The size of the stone of the train should correspond to the velocity in the gap. It should be dumped as an even layer without the formation of mounds. In the case of dumping a berm skeleton composed of large concrete blocks and elimination of the construction of a filter on its upstream slope, the formation of individual washouts at the site of closing the gap, threatening the integrity of the berm, is possible after completing the works. (Baker-IVI)
W86-00987

FLUID AND SEDIMENT INTERACTION OVER A PLANE BED,
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W86-01045

BODY-FITTED COORDINATES FOR FLOW UNDER SLUICE GATES,
Alberta Univ., Edmonton. Dept of Chemical Engineering.
J. H. Masliyah, K. Nandakumar, F. Hemphill, and L. Fung.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 922-933, June, 1985. 8 Fig, 1 Tab, 16 Ref, 2 Append.

Descriptors: *Sluice gates, *Body-fitted coordinates, *Mathematical equations, Flow discharge, Free surfaces, Gates, Velocity, Bed pressure deficit.

A boundary-fitted coordinates method was successfully employed in the evaluation of the discharge coefficients, as well as the free-surface profiles, for vertical and radial sluice gates for an ideal fluid. The values of the discharge coefficients and the free upstream and downstream surface profiles are in good agreement with the literature. Some details of the flow, such as the velocity profiles and the bed pressure deficit upstream of the gate, can also be predicted accurately. The boundary-fitted coordinates method was demonstrated to be a viable method in the study of fluid flow with initially unknown discharge and unknown free-surface profiles. (Author's abstract)
W86-01046

HEAD-DISCHARGE RELATION FOR VORTEX SHAFT,
Ecole Polytechnique Federale de Lausanne (Switzerland). Chaire de Constructions Hydraulics.
W. H. Hager.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 1015-1020, June, 1985. 4 Fig, 1 Tab, 4 Ref.

Descriptors: *Hydraulics, *Fluid mechanics, *Vortex shafts, Hydraulic head, Flow, Mathematical equations, Design criteria.

Vortex shafts (or vortex drops) are vertical structures in which fluid flows helically along the shaft axis. Compared to the conventional drop structures they are more favorable regarding the stability of the fluid and air transfer, and provide a significant energy dissipation if properly designed. The head-discharge relation of vertical vortex shafts was investigated. Head discharge relation may be represented by a single curve. Typical shaft properties (flow depth and discharge) depend only on the geometry of the shaft inlet. Once these are determined immediate determination of the governing flow characteristics is possible. Maximum possible flow depth and corresponding maximum discharge are given in order that the flow in the shaft is stable and sufficiently aerated. Comparison between the present theoretical approach and observations on model and prototype tests indicates a favorable agreement in the complete range of parameters. No scale effects have been detected. The proposed equations may be regarded as a universal head-discharge relation for vortex shafts with subcritical inflow conditions. (Baker-IVI)
W86-01053

COMPARISON OF TWO RIVER DIFFUSER MODELS,
Hong Kong Univ. Dept. of Civil Engineering.
J. H. W. Lee.
Journal of Hydraulic Engineering, Vol. 111, No. 7, p 1069-1078, July, 1985. 5 Fig, 2 Tab, 7 Ref.

Descriptors: *River diffusers, *Mathematical models, Jets, Heated water, Diffusers, Boundary effects, Velocity, River flow.

Condenser cooling water flow from steam-electric power generation is sometimes discharged into an adjacent river as a series of high velocity jets emanating from a multiport diffuser to promote rapid mixing of the heated effluent with the available river flow. A detailed comparison is made of two analytical river diffuser models: a model that accounts for the finite width of the receiving water; and a model that neglects lateral confinement. A parametric study reveals remarkably little difference in the key predictions of the velocity and contraction of the ultimate slipstream, especially with reference to a related recent study of boundary effects on multiple submerged jets. The conclusions are corroborated by detailed velocity measurements in a systematic set of experiments covering a wide range of induced flows. (Moore-IVI)
W86-01093

EFFECT OF PIER SPACING ON SCOUR AROUND BRIDGE PIERS,
Nottingham Univ. (England). Dept. of Civil Engineering.
K. R. Elliott, and C. J. Baker.
Journal of Hydraulic Engineering, Vol. 111, No. 7, p 1105-1109, July, 1985. 4 Fig, 2 Ref.

Descriptors: *Scour, *Bridges, *Piers, Soil mechanics, Flow, Vortices, Hydraulic models, Mathematical equations.

The variation of scour depth around isolated bridge piers has been extensively studied in the past. The scouring process is affected by two processes: the horseshoe vortices around the bases of the piers will interact with each other and; the flow will be accelerated by the contraction produced by the piers. How these two processes affect the scouring process is not obvious, and small scale experiments designed to investigate this concern were conducted. During the study mathematical equations were presented which considered the effect of pier spacing on scour depth. These equations have been derived only for clear water scour, for one set of pier geometries, one value of sediment type. (Baker-IVI)
W86-01095

COMPILATION OF ALLUVIAL CHANNEL DATA,
Tetra Tech, Inc., Pasadena, CA.
For primary bibliographic entry see Field 2J.
W86-01097

WAVE FORCES ON VERTICAL WALLS,
New South Wales Univ., Kensington (Australia). School of Mathematics.
J. D. Fenton.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 111, No. 4, p 693-718, July, 1985. 5 Fig, 3 Tab, 17 Ref.

Descriptors: *Wave action, *Walls, Wave force, Moment, Wave height, Standing waves, Wave length, Angle of incidence, Mathematical studies.

Formulas are presented to third order in wave height for the force and moment exerted on a vertical wall by the complete reflection of waves with an arbitrary angle of incidence. These expressions show a number of unusual features, some of which have been found previously for the special case of standing waves. They include the following: the maximum force per unit length is caused by obliquely-incident waves rather than standing waves; the second-order contribution to the load may be larger than that at first order without invalidating the solution; the greatest net force is that directed offshore under the wave troughs; and the greatest onshore force sometimes does not occur under wave crests. The formulas presented make the problem of determining the maximum load for design purposes one of finding the maximum of a given function in a space which includes as its dimensions the wave height, wave length or period, angle of incidence, and the wall length relative to the wave-length. (Author's abstract)
W86-01098

SIMPLE GOVERNING AND SURGING SIMULATION,
Queen's Univ., Kingston (Ontario). Dept. of Mechanical Engineering.
R. A. Chaplin.
International Water Power and Dam Construction, Vol. 37, No. 6, p 39-49, June, 1985. 6 Fig, 9 Ref.

Descriptors: *Simulation analysis, *Computer programs, *Hydraulics, *Turbines, Hydroelectric power, Water surging, Model studies, Hydraulic engineering, Engineering.

The underlying mathematics and the outline of a computer program are presented which should enable the user to compute the hydraulic transients occurring after a load disturbance on a turbine. The model is based on water surging equations and includes cyclic calculations to account for the standard configuration of a hydropower station in which surge tanks are located in both the headrace and tailrace tunnels. The program has been tested against the test data of certain hydro plants and has been found to give a reasonable correlation with the test results. There is some difficulty in adapting the program to high-head turbines and particularly pump-turbines because of the complex head-flow-speed relationship. Limitations and potential modifications of the computer program are discussed. (Author's abstract)
W86-01276

8C. Hydraulic Machinery

CHEREPNOV WATER LIFTER: THEORY AND EXPERIMENT,
Missouri Univ.-Columbia. Dept. of Civil Engineering.
H. Liu, M. Fessehaye, and R. F. Geekie.
Journal of Hydraulic Engineering, Vol. 111, No. 6, p 951-969, June, 1985. 7 Fig, 1 Tab, 10 Ref.

Descriptors: *Cherepnov water lifter, *Hydraulics, Hydraulic machinery, Mathematical equations, Computers, Water lifter, Potential energy, Head loss, Pumps.

The Cherepnov water lifter is a novel device to lift or pump water using the potential energy of water. A Cherepnov lifter is similar to a hydraulic ram in that the energy for pumping water comes from water, and that a portion of the inflow must be discharged to a lower place in order to lift the remaining portion of the inflow. The lifter is free of vibration and noise, and has little abrasion of parts. A theoretical and experimental investigation of the hydraulics of the little-known Cherepnov water lifter was conducted. As many as 36 algebraic and differential equations are required to predict the cyclic motion of the flow going through the lifter. With these equations, the behavior of the lifter can be conveniently analyzed on any computer having the Continuous System Modeling Program capability. Accurate predictions can be made using this approach if the head-loss coefficient of each pipe of the lifer is determined accurately. For simplicity, the head-loss coefficients can be assumed without introducing significant errors. Although more research is needed to standardize the lifter design and to evaluate its performance under field conditions, it is felt that enough has been learned to warrant the use of the lifter, at least on a trial basis. It is recommended that a computer simulation of the lifter behavior for each particular design be conducted prior to constructing any lifter. (Moore-IVI)
W86-01048

PUMPS CRUCIAL TO SUCCESS OF LONG-DISTANCE AQUEDUCTS,
McGraw-Edison Co., Mountainside, NJ.
I. Karassik.
Water Engineering and Management, Vol. 132, No. 6, p 35-38, June, 1985. 2 Fig, 1 Tab.

Descriptors: *Water conveyance, *Aqueducts, *Pumps, Water supply, Water transport, Pipelines, Costs.

Pumping technology for long-distance transmission of water is receiving deserved attention as the need to transfer supplies of this essential resource increases throughout the world. In selecting pumps, first costs, construction costs, operating costs, and maintenance must be carefully considered. Some problems in pipeline design are reviewed, including pumping over long distances, and pumping through hilly or mountainous countryside. The number of pump stations that should be installed can be determined based on the pipeline capacity and the route which it is to follow. The possibility of providing multiple units for each station and whether they should be joined in parallel or series must be considered. This analysis must be made on the basis of the range of capacities over which the pipeline will operate throughout its projected lifetime, in conjunction with the total head requirements at these varying capacities. Single-stage or multi-stage pumps are available. (Baker-IVI)
W86-01085

ADVANTAGES OF TURGO-IMPULSE TURBINES IN MICRO-HYDEL UNITS,
Central Electricity Authority, New Delhi (India).
R. K. Grover.
Indian Journal of Power and River Valley Development, Vol. 33, No 1-2, p 7-8, January-February, 1983.

Descriptors: *Turbines, *Impulse turbines, *Francis turbines, *Micro-hydel units, Hydraulic equipment, Mechanical equipment, Design criteria, Planning, Suspended solids.

A point by point comparison is made between the turgo impulse turbine and the Francis turbine. The turgo-impulse turbine is a very simple prime mover. In Francis turbines, the water is admitted through ten to twenty or more openings and controlled by a number of carefully shaped adjustable guide vanes, which is a cumbersome arrangement. In impulse turbines, the runner is set about 1.5 m above the tailwater level, so it rotates in air at atmospheric pressure. In Francis turbines, a seal is a must as the runner rotates in a pressurized chamber. Generally the running water contains suspended matter and solid particles. At high velocity and pressure, this results in wear and tear. In impulse turbines, the parts that wear out are the tip of spear, the nozzle, and after a longer period, the runner. In high head Francis turbines, the suspended particles cause rapid wear and tear. In passing through fine clearances between guide vanes and end-cover facings, and worse still between runner and clearance rings, it can quicky reduce overall effficiency by several percent. One of the major advantages of the impulse turbine is the easy accessibility of various parts for inspection and maintenance. Governing of the unit is also relatively simpler in the case of impulse turbines. The impulse turbine loses to the Francis on three points: low specific speed, head loss due to suction head, and head variation permissible 20% as compared to 25 to 35% in the case of Francis turbines. (Baker-IVI)
W86-01204

PROBLEMS AND PROSPECTS OF POWER EVACUATION MANAGEMENT FROM HYDRO STATION IN HIMALAYAN RANGES,
Uttar Pradesh State Electricity Board, Dehra Dun (India).
T. C. Agarwal, V. N. Rikh, A. K. Gupta, and G. L. Tandon.
Indian Journal of Power and River Valley Development, Vol. 33, No. 3/4, p 87-92, March/April, 1983. 1 Fig.

Descriptors: *Hydroelectric plants, *Himalayas, *Mountainous regions, *Electrical transmission, Transmission lines, Transmission towers, Planning, Construction, Switchyards, Landslides.

The Himalayas have an immense reusable energy potential, which will be tapped by a number of hydroelectric projects, most of which are located deep in the hills. Most of the hydroelectric projects which are either under construction or investigation are located in difficult hilly terrain. Some of these schemes will have very high installed capacities. Location of hydroelectric power stations in such difficult terrain presents problems in the construction of transmission lines. Landslides frequently encountered in Himalayan ranges can result in tower failure. It appears preferable to have single circuit instead of double circuit lines, since in double circuit lines there can be complete outage of both the circuits in the event of tower failure. Proper planning for the routes of transmission lines is essential for ease of construction and maintenance in hill regions. Pooling stations are useful for groups of power stations to keep the step-up voltage at individual power houses low, in order to minimize the switchyard area. The use of bundle conductor lines with special large conductors is recommended for short distances between pooling stations and individual power houses. In cases of installations where flat land is not available for construction of a switchyard, the cost of installing underground gas insulated switchgear can be less than the conventional switchyard. This cost can further be reduced by keeping the SF6 switchyard in the construction adits of underground power houses which become redundant after construction. (Moore-IVI)
W86-01205

MODERN TRENDS IN MANUFACTURING LARGE FRANCIS TURBINE RUNNERS,
National Hydroelectric Power Corp. Ltd., New Delhi (India).
B. S. K. Naidu, and V. K. Gahlot.

Indian Journal of Power and River Valley Development, Vol. 33, No. 11, p 386-393, November, 1983. 7 Fig, 3 Tab, 8 Ref.

Descriptors: *Turbines, *Turbine runners, Hydraulic turbines, Hydraulic machinery, India.

The world over, the unit capacities of hydraulic machines used for power generation and pumped storage are increasing day-by-day. The trend of constructing large units has particularly been persisting in the Francis range. With increased unit output, large runners are required to be manufactured and transported. The paper attempts to review the manufacturing involvements, materials, inspection methodology, transport limitations, site fabrication and other related aspects pertaining to the production of large runners (D > 3 m). Integrally cast, split construction, cast welded and stamp welded variants have been discussed with respect to the technology of manufacture, bringing to light the merits and demerits of each. The statistical data of large Francis runners produced by BHEL (Bharat Heavy Electrical Limited) and other leading world manufacturers have been given. Scope of application of such runners in Indian projects is discussed together with BHEL's strategy to meet the country's requirements. (Author's abstract)
W86-01218

ENERGY STORAGE: DEVELOPMENTS IN PUMPED-STORAGE,
Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Machines Hydrauliques.
P. Henry, and J. E. Graeser.
International Water Power and Dam Construction, Vol. 37, No. 6, p 13-16, June, 1985. 5 Fig, 1 Tab.

Descriptors: *Energy storage, *Pumped storage, Energy conversion, Electric power production, Electrical equipment, Electric power demand, Engineering, Generators.

Of the methods available for energy storage, pumped storage has been widely preferred as it offers significant advantages. The complete transformation process gives an overall energy output generally higher than 70%; in spite of this the operation is profitable since the cost ratio of slack period and peak period power can be three or even four to one. The concept and history of pumped storage installations in Europe is reviewed. Technological developments are such that the construction of new facilities, particularly in Western Europe, is promising. The possibility of integrating new machines into existing pumped-storage systems makes this type of energy storage economical. Pumped storage will remain the most reliable and economical means of storing large quantities of energy for a relatively long time. (Keenan-IVI)
W86-01272

TESTS ON A FRENCH ADJUSTABLE TWO-STAGE PUMP-TURBINE,
Electricite de France, Chambery. Electrical and Mechanical Div.
N. Roche, D. Lefervre, P. Robert, P. Jarriand, and J. Rondon.
International Water Power and Dam Construction, Vol. 37, No. 6, p 21-25, June, 1985. 12 Fig, 1 Tab.

Descriptors: *Turbines, *Design criteria, *Pump-turbine, Testing, Pumped storage, Hydraulic machinery.

A test program conducted with a prototype pump-turbine with two adjustable stages has provided results that will permit development of high-output pump turbines with two adjustable stages to equip pumped-storage plants with operating heads of more than 1,000 nm. The average-output prototype unit was designed to operate at between 433 and 443 m gross head in both pumping and generating modes and to have an output when generating of 38 MW and when pumping of 33 MW; rotational speed in both modes is 750 revolutions per minute (rpm) and transient speed is 1,170 rpm (generating) or 1,120 rpm (pumping). The unit used two distributors and two 8-blade, stainless steel runners. Tests were made with the two distributors at different openings, and included some of the following conditions: (1) under normal conditions and load rejections in both generating and pumping modes, with distributors synchronized, (2) under normal operations and load rejections in both modes, but with different distributor openings, (3) load rejections with one distributor locked to various opening positions, (4) shutdown and load rejections with spherical valve closure distributors being locked in position (5) back-to-back startup of the machine by one of the Pouget units (35 MW Pelton, 250 MW Francis turbines) to investigate brake-pump and reversed pump rotation quadrants and (6) finalization of dewatering/rewatering sequences and operations as a synchronous condenser in both rotational directions. Testing at the relatively low head Truel (Tarn River, France) site was conducted for convenience, but this Neyrpic-Ektricite de France machine design is intended for employment under heads ranging from 800 to 1,500 m, with a maximal output of about 30 MW per unit. (Rochester-IVI)
W86-01274

8D. Soil Mechanics

EARTHWORKS AT THE INGURI HYDROELECTRIC STATION CONSTRUCTION SITE,
G. Y. Zarandiya, L. S. Babuniya, N. N. Shartava, N. Z. Kolbazov, and U. I. Godzhiashvili.
Hydrotechnical Construction, Vol. 18, No. 8, p 382-389, August, 1984. 3 Fig, 3 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 8, p 42-47, August, 1984.

Descriptors: *Earthworks, *Dam construction, *Excavation, Tunneling, Hydroelectric plants, Underground structures, Penstocks, Tailrace, Mountainous areas, Roads, Drilling.

At the Inguri hydrostation construction site, the bulk of the earthworks is accounted for by the foundation pit of the 271.5 m high arch dam and underground structures, consisting of the pressure diversion tunnel, five penstocks, two butterfly-valve chambers, the underground powerhouse and the tailrace tunnel. Details of the earthworks associated with the construction of the Inguri Hydroelectric Station are presented. It is recommended that for construction in mountainous areas, the roads leading to the foundation pit should have a minimum of cuts, be constructed on trestles, or pass through tunnels on the slopes. During excavation of the pit it is expedient to construct a concrete support for the finished sections of the pit as the earthmovers descend toward the river channel. During the excavation of the underground structures of the hydrostation, the use of highly productive drilling and mucking equipment and heavy-duty vehicles made it possible to accelerate the construction process. For the excavation of the powerhouse chamber, optimization of the plan for transporting the loosened rock to the surface with the maximum use of all vertical and horizontal accesses promote simplification and acceleration of the operations. (Keenan-IVI)
W86-00984

STRESS-STRAIN STATE OF EARTH DAMS ON UNDERMINED TERRITORIES,
For primary bibliographic entry see Field 8E.
W86-00988

PROVISION OF STABILITY OF UNLINED CANALS,
V. S. Altunin.
Hydrotechnical Construction, Vol. 18, No. 10, p 496-503, October, 1984. 5 Fig, 4 Tab, 3 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 28-32, October, 1984.

Descriptors: *Canals, *Design criteria, Velocity, Sand, Mathematical equations, Model studies, Slopes, Vegetation.

The design and modeling of stable unlined canals in fine sand soils are discussed. The Chezy coefficient for large unlined canals should be determined by special formulas not containing the roughness coefficient. As a first approximation the value of the permissible velocity can be assayed without consideration of the flow depth. Since canals completely flowing in fine-sand soils are infrequently found, the development of biological revetments (vegetation) should be encouraged as a means of protecting slopes of unlined canals. (Keenan-IVI)
W86-00992

MODEL FOR PIPING-PLUGGING IN EARTHEN STRUCTURES,
Indian Inst. of Tech., Bombay.
K. C. Khilar, H. S. Fogler, and D. H. Gray.
Journal of Geotechnical Engineering, Vol. 111, No. 7, p 833-846, July, 1985. 5 Fig, 1 Tab, 19 Ref. NSF grant CEE-8313765.

Descriptors: *Piping, *Plugging, *Earthworks, Clay, Dispersion, Seepage stream, Particulate matter, Model studies, Soil permeability, Soil porosity, Tractive stress, Hydraulic gradient.

A capillary model was developed to predict under what conditions piping versus plugging is likely to occur as a result of clay particle dispersion in soils. In the intermediate size range, i.e., particles too small per se to clog pore constrictions and too large to wash through unimpeded, the outcome depends strongly on the concentration of dispersal particles in the seepage stream. This concentration in turn depends upon the rate at which the particles are eroded from the pore walls. The capillary model was used to ascertain the relationship between key variables at the onset of piping. This relationship involved the initial permeability and porosity of the soil, the critical tractive stress, and the hydraulic gradient. The model was also used to predict under what circumstances clay particle concentrations in the seepage stream will buildup suddenly to very high values, a condition favorable to clogging or particle holdup. Results of the analysis showed that very large particle concentration buildups tend to occur at permeabilities of less than 10 to the minus 9th power sq cm (0.0001 cm/s for water at 20 C). This prediction is consistent with previous findings reported in the geotechnical literature. (Author's abstract)
W86-01087

NONLINEAR DYNAMIC ANALYSES OF AN EARTH DAM,
Princeton Univ., NJ. Dept. of Civil Engineering.
J. H. Prevost, A. M. Abdel-Ghaffar, and S. J. Lacy.
Journal of Geotechnical Engineering, Vol. 111, No. 7, p 882-897, July, 1985. 12 Fig, 4 Tab, 20 Ref. NSf grant CEE81-20757.

Descriptors: *Earth dams, *Earthquakes, *Dynamic analysis, Computer models, Stress, Strain, Acceleration, Deformation, Vibration.

Earth dams are large three-dimensional nonhomogeneous structures constructed from zoned inelastic material; therefore, the computation or prediction of their dynamic responses to earthquake shaking is extremely difficult. The results of 2D nonlinear and 3D nonlinear dynamic finite element analyses of an earth dam subject to two very different input ground motions are compared. A comparison between measured and computed earthquake responses of the dam is also presented. The study is based on rigorous nonlinear hysteretic analyses utilizing a multi-surface plasticity theory. The backbone shear stress-strain curve is assumed hyperbolic and symmetrical about the origin. Detailed comparisons of induced stresses, strains, accelerations, and permanent deformations at various locations in the dam are presented. Only slight differences are found between the results of 2D and 3D nonlinear analyses. The differences are somewhat pronounced in the upstream-downstream direction for the strong shaking case. The study demonstrates the importance of three-dimensionality on the dynamic earthquake response of earth dams, particularly in computing resulting permanent deformations. For the moderate shaking case, there is reasonable good correlation between the crest acceleration time histories computed with the 2D and 3D nonlinear dam models. Some differences are observed for the strong shaking models in crest acceleration time histories, induced stresses

and strains in the dam material and resulting permanent deformations. The 3D nonlinear analyses are several orders of magnitude more expensive than their 2D counterparts. The 3D analyses are reliable tools to account for all possible vibration modes of the dam and all three components of ground shaking, to realistically predict the dam response, and to provide longitudinal response parameters. (Moore-IVI)
W86-01088

CHEMICAL GROUTING IN SOILS PERMEATED BY WATER,
Northwestern Univ., Evanston, IL. Dept. of Civil Engineering.
R. J. Krizek, and T. Perez.
Journal of Geotechnical Engineering, Vol. 111, No. 7, p 898-915, July, 1985. 14 Fig, 3 Tab, 3 Ref.

Descriptors: *Chemical grouting, *Soil grouting, Geohydrology, Cohesionless soils, Grout injection, Gel time, Viscosity, Saturated soils, Sand, Gravel.

Based on data obtained from seventy-nine large-scale one-dimensional laboratory tests, limiting conditions were established to define the transition zone between retention and elutriation and chemical grout injected into a cohesionless soil permeated by water. Various combinations of four grouts, four sands, and one gravel were included in the experimental program, and the interpretation is presented in terms of seepage velocity versus gel time relationships. The position and extent of the transition zone are strongly dependent on the viscosity and miscibility of the grout and to a lesser extent, on the effective grain size of the soil. These parameters are largely responsible for the dilution that occurs and that, in turn, lengthens the gel time and decreases the viscosity, thereby governing the distribution of the injected grout and the resulting permeability of the soil. Even if a water seal is established, the grout may be dissolved or eroded, or both, after a relatively short time. Measurements from a limited number of tests demonstrate that the strength is substantially higher in the vicinity of the injection point. (Author's abstract)
W86-01089

RISK ANALYSIS FOR SEISMIC DESIGN OF TAILINGS DAMS,
Consulting Geotechnial Engineer, Box 643, Indian Hills, Colo. 80454.
S. G. Vick, G. M. Atkinson, and C. I. Wilmot.
Journal of Geotechnical Engineering, Vol. 111, No, 7, p 916-933, July, 1985. 8 Fig, 5 Tab, 29 Ref.

Descriptors: *Mine wastes, *Earthquake engineering, *Tailings dams, *Risk analysis, Nevada, Liquefaction, Dam design, Dam failure, Costs.

Probabilistic seismic risk analysis is a promising method for evaluating design options and establishing seismic design parameters. However, there have been few examples in the literature to guide practitioners in its use. This paper demonstrates the value of risk analysis for mine tailings dams and provides a case-history application for a seismically active portion of Nevada. Risk analysis provided the basis for selecting among design options having varying liquefaction resistance, and for establishing input parameters for dynamic analysis. Ranges are presented for the quantity and cleanup cost of tailings released in seismic failures to aid in determining expected failure consequences. It is shown that for many tailings dams, accepted lifetime failure probabilities of a few percent may provide a reasonable basis for probabilistic determination of seismic design criteria. (Author's abstract)
W86-01090

EXPERIMENTAL INVESTIGATION OF HYDRAULIC FRACTURING,
Kabul Univ. (Afghanistan). Faculty of Engineering.
A. W. Hassani, B. Singh, and S. S. Saini.
Indian Journal of Power and River Valley Development, Vol. 33, No. 5/6, p 181-187, May-June, 1983. 10 Fig, 15 Ref.

Descriptors: *Hydraulic fracturing, *Soil physical properties, Confining stress, Saturated soils, Unsaturated soils.

An experimental investigation has been carried out to study the hydraulic fracturing phenomenon in soils. Cylindrical specimens have been tested under various cell pressures in a triaxial testing apparatus. Internal pressure is gradually applied through a needle inserted axially in the specimen until failure occurs while external pressure is kept constant. Tests are conducted for saturated as well as unsaturated soil specimens. In order to corroborate the experimental results, a theoretical analysis considering linear, elastic behavior of the soil is also carried out. It is considered that hydraulic fracturing will take place when the effective stress in the soil mass is tensile and equals the tensile strength of the soil. Linear relationship of hydraulic fracturing pressure and confining stress is obtained both theoretically and experimentally. The theoretical results show somewhat lower values compared with those obtained experimentally. It is observed that hydraulic fracturing pressure required to cause cracking is more than the confining stress. (Author's abstract)
W86-01207

MANAGEMENT OF MUD, PROBLEMATIC IN THE FOUNDATIONS OF CHANDAN AND GETALSUD EARTH DAMS IN BIHAR (INDIA),
Masan Dam Investigation Div., Bagaha (India).
C. Singh.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 309-311, 308, September/October, 1983.

Descriptors: *Earth dams, *Mud, *Chandan Dam, *Getalsud Dam, *India, Soil properties, Dam foundations, Dam construction.

Getalsud Earth Dam across the river Subernarekha in Ranchi District of Bihar was constructed during 1966-69 to intercept 725 sq km of unobstructed catchment of the Subernarekha below Matia Dam for hydel generation and additional water supply to Ranchi township. The mud, found or formed in the foundation of the earth-fill dam was troublesome. The mode of management depended upon the accessibility, the workability, the available time and the extent of security to be ensured. The natural drying, the impregnation of coarse grained heavier materials and squeezing out of excess water by porous material loading were among the main corrective measures practiced in Chandan and Getalsud Earth Dams, in which heavy duty towed scrapers and dozers were intelligently used for removal of mud. In most cases the management of the mud problem lay in heavy earthmoving machinery and not in manual labor. (Baker-IVI)
W86-01213

TECHNOLOGY OF REINFORCED EARTH WALLS,
H.Q.C.E. (P.), Dautak, C/o 99 APO.
G. G. K. Moorthy.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 312-319, September-October, 1983. 10 Fig, 5 Tab, 8 Ref.

Descriptors: *Earth dams, *Earthworks, *Reinforced earth, Soil physical properties, Stress, Friction, Strength, Dam construction, Costs.

Reinforced earth is an economical means of improving the mechanical properties of the basic material, earth, by reinforcing it in the directions in which it is subject to the greatest stresses. The essential phenomenon in reinforced earth is the friction between the earth and the reinforcements. Through this friction, the earth transmits to the reinforcements the stresses which develop in the mass; the reinforcements are thereby placed in tension and the result is as though the earth possessed a cohesion in the directions in which the reinforcements are placed. This cohesion which is generated is directly proportional to the tensile strength of the reinforcements. The soil used in a reinforced earth structure should meet certain minimum criteria to ensure the development of sufficient friction between the earth and the reinforcements, and to ensure that no interstitial pore water pressures develop within the reinforced earth structure. The size, spacing and length of reinforcing strips are determined by calculation of internal stability of the reinforced earth structures. The flexibility of the reinforcing strips and their tensile strength are the essential elements in these calculations. The service life of a reinforced earth structure depends primarily on the resistance of the reinforcing strip to soil corrosion. Costs of reinforced earth construction are briefly considered along with advantages to using the reinforced earth technique for dam construction. (Baker-IVI)
W86-01214

8E. Rock Mechanics and Geology

WAYS OF USING THE BEARING PROPERTIES OF A ROCK MASS WHEN DESIGNING UNDERGROUND HYDRAULIC STRUCTURES,
V. F. Ilyushin.
Hydrotechnical Construction, Vol. 18, No. 8, p 357-364, August, 1985. 4 Fig, 7 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 8, p 21-25, August, 1984.

Descriptors: *Rock mechanics, *Design criteria, *Hydraulic structures, *Underground structures, Construction, Rock properties, Site selection, Geology, Linings, Coatings, Seismicity, Pressure, Groundwater.

One of the main principles of developing economic layouts and designs of underground hydraulic structures is the use of the bearing properties of the surrounding rock mass. With consideration of the available design, construction, and operating experience and tendencies toward an improvement of underground hydraulic structures, a number of general and particular directions can be followed. One of the first stages is the analysis of the engineering-geologic conditions of the construction territory and selection of the site of the underground hydraulic structure. Measures should be taken to make the best use of the rocks, including: artificial stabilization of rocks; efficient structure layout; use of shapes which are the most stable under the given conditions; and the use of linings and coatings. Seismic factors must also be taken into account. Laboratory investigations should be conducted on large-scale and two- as well as three-dimensional models permitting a reliable determination of the stress-strain state of the structure. Driving technology can be used to provide minimum disturbance of the rocks in the vicinity of the working. Inspection during and after construction is essential for underground structures. A number of underground hydraulic structures along with examples are given: structures experiencing rock pressure; pressure structures absorbing groundwater pressure; and outlet structures. (Shieh-IVI)
W86-00982

GENERALIZED RELATIONS BETWEEN STATIC AND DYNAMIC INDICES OF ROCK DEFORMABILITY,
A. I. Savich.
Hydrotechnical Construction, Vol. 18, No. 8, p 394-400, August, 1984. 5 Fig, 2 Tab, 15 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 8, p 50-54, August, 1984.

Descriptors: *Deformation, *Rock properties, Seismic properties, Acoustic properties, Elasticity, Rock testing, Rock mechanics.

Seismic acoustic methods have been used to study the elastic and deformation properties of rock masses. The correlation between the characteristics of the medium determined in the seismic acoustic investigation and the indices of its deformation properties (the static modulus of elasticity and modulus of deformation) are the basis of a quantitative evaluation fo the indices of rock deformability. When solving many problems in practice, the deformation properties of rocks in their natural occurrence can be determined with sufficient accuracy from the data of seismic acoustic measurements

without conducting labor-intensive and costly static tests. (Keenan-IVI)
W86-00985

STRESS-STRAIN STATE OF EARTH DAMS ON UNDERMINED TERRITORIES,
V. F. Markevich, V. I. Teleschev, and A. K. Bugrov.
Hydrotechnical Construction, Vol. 18, No. 10, p 472-477, October, 1984. 3 Fig, 10 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 12-15, October, 1984.

Descriptors: *Mining, *Dam stability, *Earth dams, *Foundation failure, Dam failure, Construction, Dams, Embankments, Stress, Strain, Deformation, Tension cracks.

Underground mining causes deformations of the ground surface and affects engineering structures falling in the zone of influence of mining operations. Detection of the possibility of undermining of the foundations of earth dams is related to an investigation of their stress-strain state in the presence of deformations of the foundation being undermined, establishment of the limit values of these deformations, and development of special protective measures ensuring the normal operation of the dams in the presence of deformations exceeding the limit. A method is proposed for calculating the stress-strain state of earth dams and embankments located on foundations being undermined. As a result of the mathematical investigations the characteristics of the development of limit equilibrium zones and changes in all components of the stress-strain state were stablished. A substantial effect of the curvature of convexity of the foundation was found and the values of the limit strains of the foundation for homogeneous dams of cohesive soils with a dam height of 10-30 m were estabished. The occurrence of tension cracks in earth dams during undermining of the foundations represents an additional danger in connection with the fact that they are concentrators leading to the development of strains and eventually to growth of the crack. (Baker-IVI)
W86-00988

ELASTIC DEFORMATION OF THE FOUNDATION OF THE BRATSK CONCRETE DAM,
V. G. Ivanov.
Hydrotechnical Construction, Vol. 18, No. 10, p 492-495, October, 1984. 2 Fig, 1 Tab, 3 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 25-27, October, 1984.

Descriptors: *Deformation, *Dam foundations, *Settlement, Concrete dams, Reservoir operation, Bench marks, Rock mechanics, Elastic deformation.

Measurements of settlement of structures at the Bratsk hydroelectric station have been conducted since the start of filling the reservoir (September 1961). Analysis of the data yielded several results. Recommendations are made regarding the required degree of accuracy in measuring settlement. After filling the reservoir, more accurate methods become necessary. It is necessary to consider whether near-by bench marks are in the zone of deformation of the rock foundation. If so, this will distort the results. At this hydrostation with relatively small drawdowns of the reservoir it was possible to detect elastic behavior of the rock foundation of the dam. (Keenan-IVI)
W86-00991

SIMPLIFIED EARTHQUAKE ANALYSIS OF CONCRETE GRAVITY DAMS: SEPARATE HYDRODYNAMIC AND FOUNDATION INTERACTION EFFECTS,
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W86-01080

SIMPLIFIED EARTHQUAKE ANALYSIS OF CONCRETE GRAVITY DAMS: COMBINED HYDRODYNAMIC AND FOUNDATION INTERACTION EFFECTS,
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W86-01081

INVESTIGATION OF DAM SITES: MODERN PRACTICES,
National Hydroelectric Power Corp. Ltd., New Delhi (India).
V. Ram, and S. K. Roy.
Indian Journal of Power and River Valley Development, Vol. 33, No. 9/10, p 278-281, September-October, 1983. 3 Ref.

Descriptors: *Dam foundations, *Site selection, *Reservoir siting, India, Planning, Evaluation, Dam construction, Decision making.

Methods currently in use in developed countries for reconnaissance and investigations of rock foundations for large dams are reviewed. The various in situ investigation methods in practice in European countries include: structural geology survey; graphical presentation of structural geology; geophysics; petite sismique; rock quality designation; Lungeon test; and Jacking test. Some of the methods are already in use in India, while some can be suitably modified according to Indian conditions. Stress should be laid on investigation methods which are expeditious and yield reliable results so that hydel projects which have a longer gestation period in India can be commissioned within 6-8 years instead of 10-15 years which is the case for many of the ongoing projects. Accuracy of the investigation is also desired so that the predictions made by geologists are not unreliable which sometimes leads to serious construction problems not anticipated originally and leads to adoption of a new method of construction, increasing the quantum of work, thus leading to an increase in estimated costs and extending the construction schedule. (Baker-IVI)
W86-01210

MECHANIZED TUNNELLING - A LANDMARK IN INDIAN TUNNELLING PRACTICE,
National Hydroelectric Power Corp. Ltd., New Delhi (India).
For primary bibliographic entry see Field 8A.
W86-01216

8F. Concrete

ON-SITE TESTS OF A NEW TYPE OF TUNNEL LINING AT THE NUREK HYDROSTATION CONSTRUCTION SITE,
V. V. Rukin, and V. L. Kuperman.
Hydrotechnical Construction, Vol. 18, No. 8, p 345-356, August, 1984. 13 Fig, 19 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 8, p 13-20, August, 1984.

Descriptors: *Tunnel linings, *Linings, *Latex concrete, Concrete technology, Elasticity, Deformation, Strength, Tunnels.

The maximum use of the bearing capacity of the rock mass is one of the principal ways to reduce the thickness of linings of hydraulic pressure tunnels. A new material, latex concrete, can be used to allow the rock to absorb the load from the internal pressure of the water because it can provide the necessary yielding and elasticity at a high tensile strength. The addition of synthetic styrene-butadiene latex SKS-65GP to the concrete mix in the amount of about 10% of the dry weight of the cement leads to a decrease of the modulus of deformation of concrete by more than two fold. The addition of latex to concrete makes it possible to reduce the water/cement ratio and to improve the technological properties of the concrete mix - fluidity, plasticity, and workability. Latex concrete can be prepared in ordinary concrete mixers and does not cause additional difficulties in concrete works. Large-scale investigations in an experimental gallery of tunnel 9-TTs at the Nurek hydrostation construction site were undertaken to obtain the data on the work of a tunnel with latex concrete in contact with massive rock and to perfect the technological parameters of concreting. The high elasticity of the latex concrete in combination with its increased ultimate tensile strength makes it possible to reduce the thickness of latex concrete linings compared with ordinary concrete by at least half. For the permanent headrace tunnels of the Nurek hydrostation show that the use of the latex concrete makes it possible to dispense with reinforcement of the lining and to use consolidation grouting of the rock with a total saving of 0.5 million rubles. In the near future latex concrete will be used in the linings of hydraulic structures (pressure tunnels) at a number of installations. (Shieh-IVI)
W86-00981

USE OF CAST-IN-PLACE CONCRETE TEMPORARY SUPPORT IN HYDRAULIC TUNNELS,
M. G. Bikineev, and B. D. Mal'tsev.
Hydrotechnical Construction, Vol. 18, No. 8, p 364-370, August, 1984. 3 Fig, 6 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 8, p 25-29, August, 1984.

Descriptors: *Concrete technology, *Cast-in-place concrete, *Concrete temporary support, *Tunnels, Construction, Linings, Hydroelectric plants.

The cast-in-place concrete temporary support (CTS) constructed by means of traveling formwork can be used to solve problems of saving acutely scarce metal (metal arches) and to provide safe underground working conditions in weakly stable rocks. Two types of CTS are currently used: a support capable of performing the function of permanent lining and a support contructed for the period prior to the construction of permanent lining. The CTS has been used in a number of hydrostation projects. The use of CTS is related mainly to determination of weak stability in sections of the rocks being tunneled. The possibility of rockfalls depends not only on the strength of the rock mass but also on the cross-sectional shape and span of the tunnel and length of its unsupported section. Therefore, the selection of the limiting distance of the CTS from the face is important. The reliability of the CTS is also determined by the forces of the bearing pressure of the rocks in the arch on the rocks in the tunnel face and on the constructed support behind the face. The CTS can be used in rocks with a strength coefficient less than 2 and specially in zones of tectonic deformations. The stability of the rocks should be evaluated and analog methods as well as laboratory modeling should be used. Moreover, additional laboratory and on-site investigations are needed for developing calculations for CTS and the construction technology. (Shieh-IVI)
W86-00983

EVALUATION OF THE STRENGTH AND DEFORMABILITY OF CONCRETE OF MASSIVE HYDRAULIC STRUCTURES,
V. M. Vlasov, V. I. Veretyushkin, L. M. Deryugin, and A. S. Moiseenko.
Hydrotechnical Construction, Vol. 18, No. 10, p 478-484, October, 1984. 2 Fig, 3 Tab, 8 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 15-19, October, 1984.

Descriptors: *Strength, *Concrete technology, Hydraulic structures, Core tests, Cube tests, Prism tests, Deformability.

When evaluating the quality of concrete on the basis of core test data there is some difficulty in converting to strength of standard cube and prism test specimens. This conversion is influenced by the scale effect, aggregate size, effect of the boundary conditions of load application, geometry of the specimen, technology of preparing the specimens, and moisture content of concrete. An evaluation of the effects of all of the factors separately on the strength and deformability of concrete of a massive structure is a difficult problem; the accuracy of the evaluation will be low, because of interaction of the factors. Based on a comparison of core test data and standard test speciments, equations are developed for the conversion. The overall possible decrease of the calculated strength due to the interraction of weak and strong regions of the concrete layers of a massive structure will be 10%.

This additional reserve of strength should be taken into account at the design stage. (Keenan-IVI)
W86-00989

ASPHALTIC CONCRETE LININGS FOR PUMPED-STORAGE RESERVOIRS,
Strabag Bau-A.G., Cologne (Germany, F.R.).
W. D. Geiseler, and W. Kuhlmann.
International Water Power and Dam Construction, Vol. 37, No. 6, p 17-20, June, 1985. 8 Fig, 4 Ref.

Descriptors: *Reservoirs, *Linings, *Asphaltic concrete, Asphalt, Construction, Sealants, Slope.

Review of performance and inspection results for asphaltic-concrete linings in pumped-storage reservoirs at Waldeck II and Glems (Federal Republic of Germany), Ludington, Michigan, and Coo I and II (Belgium) demonstrates that this type of sealing has performed well. Large areas of the linings on the reservoir bottom and slope required only very minor maintenance work. Failures that did occur were found at joints between the asphaltic-concrete lining and a concrete abutment (Glems), as a result of motion of an intake structure, which caused the lining to fold as it was moved by the structure to which it was attached (Ludington), and at the joint between the intake structure and the surrounding lining (Coo). In all four reservoirs, failures of the lining itself were limited to minor cracks and occasional bubbles. Special attention in design and construction should be given to the joints between the bituminous lining and concrete structures. The initial impounding should be carried out slowly enough to allow the various structures and materials to adapt to changing conditions. Regular inspection of asphaltic-concrete linings is still necessary, however, and any defects should be repaired immediately. (Rochester-IVI)
W86-01273

8G. Materials

POWER CONDUITS FOR HIGH-HEAD PLANTS,
Innsbruck Univ. (Austria). Inst. fuer Konstruktiven Wasserbau und Tunnelbau.
For primary bibliographic entry see Field 8A.
W86-01277

8I. Fisheries Engineering

EFFECTS OF REDUCED DISCHARGE ON PRODUCTION AND DISTRIBUTION OF AGE-0 RAINBOW TROUT IN SEMINATURAL CHANNELS,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
D. M. Rimmer.
Transactions of the American Fisheries Society, Vol. 114, No. 3, p 388-396, May, 1985. 3 Fig, 5 Tab, 28 Ref.

Descriptors: *Ecological effects, *Stream discharge, *Trout, *Fish behavior, Fish migration, Abundance, Growth, Production, Migration, Animal behavior, Population density.

The effects of reduced discharge on emigration, abundance, growth, production, and distribution of underyearling rainbow trout, Salmo gairdneri, were studied in small, seminatural experimental streams in New Zealand. Three stream channels had constant discharges of 0.125 cu m/s from mid-November (spring in southern hemisphere) to mid-February. Discharge was then reduced in two channels, but remained unchanged in the third. Reduction of discharge by 32% (to 0.085 cu m/s) and by 60% (to 0.050 cu m/s) caused no increase in downstream emigration, the emigration rate immediately before reduction being 0.1-0.7 fish/d and that for 5 months after reduction being 0.0-0.3 fish/d. However, the results may have been influenced by unequal population sizes in the channels before the discharges were altered. Presumably, these differences were caused by unequal hatching success of eggs planted in the channel substrates. Population density was greatest (41/100 sq m) in the channel selected for control discharge. Following discharge alteration, this pattern continued (lowest discharge: 21/100 sq m; control: 7/100 sq m). Fish size differences between channels at the end of the experiment (7 July) were in direct relation to channel discharges and in inverse relation to population density (largest fish in the control and smallest fish in the low discharge channel). Reductions in instantaneous growth rates were attributable to reduced discharge, but occurred about 2 months after discharge reduction. Reduced discharge depressed production after about 1.5 months and by the end of the experiment there had developed a direct relationship between discharge and production; production was 1.4 g/100 sq m at 0.125 cu m/s and -3.8 g/100 sq m at 0.050 cu m/s. There were no significant differences among the channels in the distribution of fish among riffle, pool, and run habitat types. Before discharge reduction, fish in all channels occurred mostly in the riffles and, after reduction, fish in control and treated channels became progressively more evident in the pools. Discharge reduction had no effect on this distribution. (Author's abstract)
W86-01150

SWIMMING PERFORMANCES OF THREE RARE COLORADO RIVER FISHES,
Utah Cooperative Fishery Research Unit, Logan.
C. R. Berry, Jr., and R. Pimentel.
Transactions of the American Fisheries Society, Vol. 114, No. 3, p 397-402, May, 1985. 1 Fig, 2 Tab, 40 Ref.

Descriptors: *Colorado River, *Fish, *Fish behavior, *Fish swimming ability, Entrainment, Fish physiology, Squawfish, Chubs, Animal behavior, Water temperature.

A stamina tunnel was used to determine the prolonged swimming performance of age-0 humpback chubs (Gila cypha), bonytail chubs (G. elegans), and Colorado squawfish (Ptychocheilus lucius) and of subadult Colorado squawfish. The 'fatigue velocity' in body lengths per second at which 50% of the test fish were fatigued (FV50) was determined at 14, 20, and 26 C. The range of FV50 values for the three fishes (average total length in parentheses) were: humpback chubs (95 mm), 4.4-5.7; bonytail chubs (99 mm), 4.7-5.8; small Colorado squawfish (104 mm), 4.0-4.5; large Colorado squawfish (432 mm), 2.0-2.3. Absolute speed of large Colorado squawfish was about 2.4 times that of small Colorado squawfish. Swimming ability of the subyearlings increased with increased water temperature. These rare fish had prolonged-swimming abilities similar to other fish species. (Author's abstract)
W86-01151

MORTALITY OF JUVENILE AMERICAN SHAD AND BLUEBACK HERRING PASSED THROUGH A LOW-HEAD KAPLAN HYDROELECTRIC TURBINE,
Massachusetts Cooperative Fishery Research Unit, Amherst.
R. E. Taylor, and B. Kynard.
Transactions of the American Fisheries Society, Vol. 114, No. 3, p 430-435, May, 1985. 1 Fig, 2 Tab, 15 Ref.

Descriptors: *Turbines, *Mortality, *Shad, *Herring, Fish migration, Hydroelectric plants, Low-head hydropower, Cavitation, Controlled surface sillage, Fish behavior.

The objectives of this study were to determine the immediate turbine induced mortality of juveniles at a lowhead hydropower facility during natural downstream migration and to test for differences in fish mortality associated with three levels of electrical generation. Turbine induced mortality was estimated at 62% for the 16.5 MW mode of generation, and 82% for both the 12.0 MW and 5.5 MW modes. There were no significant differences in the recovery rates for prekilled fish or control fish among treatments, but there were for test fish. Recovery of test fish increased with electrical output of the turbine. Cavitation is thought to be the most important source of mortality to juvenile fish passed through Kaplan turbines. Whether or not controlled surface sillage at a dam would be an effective method of bypassing juveniles around the turbines is not known but preliminary indications are encouraging. Also, the peak in daily movement of juvenile American shad is between 1800 and 2000 hr EST during outmigration. This could minimize mortality because the turbines are typically under moderate to heavy loads at night and are usually running at the 26.5 MW generation mode. (Baker-IVI)
W86-01155

SIMULATING FISH REDISTRIBUTION IN THE LG-2 RESERVOIR AFTER FLOODING,
Sherbrooke Univ. (Quebec). Dept. of Chemical Engineering.
K. A. Morrison, N. Therien, and B. Coupal.
Ecological Modelling, Vol. 28, No. 1/2, p 97-111, May, 1985. 7 Fig, 2 Tab, 15 Ref.

Descriptors: *Fish populations, *Model studies, *Reservoirs, *Fish behavior, *Reservoir fisheries, *Flooding, *LG-2 Reservoir, *La Grande Hydroelectric Complex, *Quebec, Reservoir operation, Fisheries management, Species distribution, Fish migration, Populations, Animal behavior.

The changes that occur to fish movements and distributions as a result of the flooding of a large reservoir are not well known. Some of the mechanisms causing such changes can be identified. A model was developed of the movements of fish populations in the LG-2 reservoir of the La Grande Hydroelectric Complex in Quebec over the 2 years following innundation. The only processes examined by the model are dilution and depth changes. The purpose of the model is to provide approximate estimates of what would occur to observed fish catches if these were the only processes going on; the model thus provides a null hypothesis against which experimental data can be compared to evaluate the importance of the other processes affecting fish distributions during and immediately after flooding. Two species are examined, the walleye (Stizostedion vitreum) and the longnose sucker (Catostomus catostomus), and results were compared to observations. The only processes examined by the model are dilution and depth changes. Population distributions and water depth were plotted using a three-dimensional graphing system. The model predictions are fairly close after the 1st year but diverge from observations at several stations after the 2nd year. This divergence may be due to the adaptation of the populations to new spawning areas, a factor not yet considered in the model. One area requiring more research is habitat preference of deeper-water species. The model is also simplistic in that it does not allow for seasonal changes in habitat preferences. Movements to spawning areas fall within this set of factors. The inclusion of these effects will allow the model to make more realistic projections into the future, and will allow some examinations of the influences of the managed bays on fish distributions. (Collier-IVI)
W86-01166

GROWTH RATE OF YEARLING COLORADO SQUAWFISH AT DIFFERENT WATER TEMPERATURES,
National Fisheries Center-Leetown, Kearneysville, WV.
For primary bibliographic entry see Field 6G.
W86-01169

9. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

WATER RESOURCES ENGINEERING EDUCATION,
Virginia Water Resources Research Center, Blacksburg.
For primary bibliographic entry see Field 6B.
W86-01107

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